

SALMAN H. AL-ANI

# ARABIC PHONOLOGY

MOUTON





## ARABIC PHONOLOGY

# JANUA LINGUARUM

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# ARABIC PHONOLOGY

An Acoustical and Physiological Investigation

*by*

SALMAN H. AL-ANI

INDIANA UNIVERSITY



1970

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THE HAGUE • PARIS

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*This book is dedicated to the late  
Dr. Gordon E. Peterson whose untimely death  
occurred before its publication.*



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*December, 1966*  
*Montreal, Quebec, Canada*

S.H.A.





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## TABLE OF SYMBOLS

$F_1$ ,  $F_2$ ,  $F_3$ , etc. Formants 1, 2, 3, etc.

cps cycles per second

msec milliseconds

/ / phonemic transcription

[ ] phonetic transcription

+ indicates possibility of occurrence of a consonant cluster — see  
Charts III and IV, pages 79 and 80

V vowel

C consonant

' primary stress

` secondary stress

/1/ low pitch level

/2/ mid pitch level

/3/ high pitch level

/4/ extra high pitch level

↑ final pause — rising

↓ final pause — falling

→ non-final pause



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## INTRODUCTION

Arabic is a Semitic language. Historically it is formed of two branches: South Arabic and North Arabic. The Southern branch is found in South Arabia and includes, among others, the Sabaeen and Himyarite languages which we know of through inscriptions dating from the pre-Christian era to the 6th century A.D. It is similar to North Arabic in its grammatical forms as well as in its vocabulary. South Arabic became a dead language after the fall of the Himyarite Empire, which was overthrown by the Abyssinians in the 6th century A.D. From then on the Northern branch established itself as the 'lingua franca' of the Arabs.<sup>1</sup>

Judging by the poetry of the Jāhiliyya period,<sup>2</sup> after North Arabic began its triumphant career it developed into a very rich and poetic language and became the common literary medium of pre-Islamic Arabia. It assumed a unique and overwhelming importance with the advent of Islam as the sacred language of the Koran and the everyday speech of an energetic and conquering people. It attained a dominance which it has never lost, not only in Arabia but throughout the lands of Islam.

It is a known fact that the Arabic language did not receive the attention of western scholars until the beginning of the 19th century. The process of evolution through which the language has passed from its early beginning to the present continues to be an important and fruitful field of study.

Arab philologists and grammarians have traditionally been concerned with the diachronic linguistics of the language. Some of them however have done a great deal of work on the synchronic aspects of the language. One of the earliest and most complete studies of classical Arabic was done by Sībawayh in his great work known as *al-Kitāb* 'The Book'.

<sup>1</sup> H. A. R. Gibb, *Arabic Literature* (London, Oxford University Press, 1926), pp. 9-13; Ignaze Goldziher, *A Short History of Arabic Literature* (Hyderabad-Deccan, The Islamic Culture Board, pp. 2-4; R. A. Nicholson, *A Literary History of the Arabs* (Cambridge University Press, 1956), see introduction.

<sup>2</sup> Jāhiliyya, a term capable of being rendered as the 'Period of Ignorance' or the period of 'Rudeness', is a derogatory designation applied to the pre-Islamic period.

Contemporary Standard Arabic, a modernized version of classical Arabic, is the language commonly in use in all Arab speaking lands today. It is the language of science and learning, of literature and the theater, and of the press, radio and television. Notwithstanding the unanimous acceptability of Contemporary Standard Arabic and its general adoption as the common medium of communication throughout the Arab world, it is not the everyday speech of the people. Tunisians, Egyptians, Syrians and Iraqis, among others, whether peasants, townspeople or nomads, find it easier and more convenient to express themselves in their own particular dialect. The differences in the phonology, morphology and syntax of these dialects are often so great that verbal communication between an illiterate Egyptian and an illiterate Iraqi, whether they be townsmen or peasants, is difficult if not impossible. Consequently, a knowledge of Contemporary Standard Arabic becomes imperative if speakers of the various regional dialects are to communicate with each other.

The aim of this work is to present a systematic study of the phonology of Contemporary Standard Arabic as used in Iraq. Needless to say, the phonology varies, however slightly, from one Arab country to another.

In reaching the tentative conclusions throughout this study, the author relied heavily on acoustical and physiological methods. The work was first initiated in 1963 at Indiana University as a PhD thesis. From that time to the present date extensive research has been done — including the making of a considerable number of spectrograms and X-ray sound films — which helped to reshape the work into its present form.

# I

## ACOUSTICAL AND PHYSIOLOGICAL PROCEDURES INFORMANTS

### A. SPECTROGRAPHIC ANALYSIS OF DATA

Primarily the spectrographic analysis of speech produces a visual display that shows the frequency dimension of utterances vertically and the time dimension horizontally, while the intensity is shown by varying degrees of blackness — depending on the source.

In the preparation of this book, three types of spectrographic analyses were used :

#### 1. *Broad Band*

Basically, the broad band spectrogram involves analysis with a 300 cps filter which results in the display of formant structures. These formant structures are “regions-of-energy-concentration”.<sup>1</sup> The formants appear horizontally starting at the bottom of the spectrograms and are called Formant 1 ( $F_1$ ), Formant 2 ( $F_2$ ), and Formant 3 ( $F_3$ ), etc. The broad band analysis was very helpful in the analysis of the segmental phonemes of the present study.

#### 2. *Narrow Band*

The narrow band spectrogram involves analysis with a 45 cps filter which results in the production of harmonic structures. The narrow band analysis was utilized in the investigation of pitch and intonation.

#### 3. *Continuous Amplitude Display*

This display, which is useful in the study of the overall intensity of an utterance, is produced by means of a special circuit that is attached to the spectrograph. This display proved to be helpful in the study of stress.<sup>2</sup>

<sup>1</sup> H. M. Truby, “A Note on Visible and Indivisible Speech”, *Proceedings of the VIII International Congress of Linguists*, (Oslo, Oslo University Press, 1958), p. 394.

<sup>2</sup> For more detailed information on spectrographic analysis see: C. Gunnar Fant, “Modern Instruments and Methods for Acoustic Studies of Speech”, *Proceedings of the VIII International*

Approximately 2000 spectrograms were made, measured and tabulated in the preparation of this book. Some of them were made at Indiana University in 1963, some at the Phonetic Laboratory at McGill University, Montreal, during 1964-1965 and the majority at the Communication Sciences Laboratory at Ann Arbor, Michigan, in the summer of 1966. All of the spectrograms used for illustration purposes were made at Ann Arbor and are of the author's speech.

The spectrographic data were organized in the following manner:

- (1) Vowels in isolation.
- (2) Consonant-vowel sequences (each consonant was recorded with both short and long vowels).
- (3) Minimal pairs in lexical items.
- (4) Short phrases and sentences.

By making spectrograms for each vowel in isolation it was possible to obtain the characteristic acoustic patterns of the vowels.

The next step was to obtain the characteristics of each consonant from the consonant-vowel sequences and to observe the influence of each consonant on each vowel and vice-versa.

After obtaining the information revealed by these two steps, the onsets, steady-states, and offsets of each vowel formant and of whatever formant information showed for the consonants were measured. All of the results were then tabulated and classified.

Through these procedures it became possible to determine the influence of the sounds on each other.

In this study, special emphasis is being directed towards the pharyngeals and pharyngealized consonants. All durations listed are relative and figures quoted are approximate; *cps* stands for cycles per second and *msec* stands for milliseconds.

## B. X-RAY SOUND FILMS

A further investigation of the problematic aspects of the consonant-vowel sequences was carried out on a physiological level by making X-ray sound films at the Department of Otolaryngology and Maxillofacial Surgery, University of Iowa, Iowa City, Iowa.<sup>3</sup> Two films were made and are on file — together with a script — at the University of Iowa.

*Congress of Linguists* (Oslo, Oslo University Press, 1958), pp. 282-353; Eli Fischer-Jørgensen, "What Can the New Techniques of Acoustic Phonetics Contribute to Linguistics", *Proceedings of the VIII International Congress of Linguists* (Oslo, Oslo University Press, 1958), pp. 433-478; Ilse Lehisté, "An Acoustic Phonetic Study of Internal Open Juncture", *Phonetica*, Vol. 5, No. 1 (Basel, S. Karger, 1960), pp. 16-17; and Gordon E. Peterson, "Phonetics, Phonemics, and Pronunciation: Spectrographic Analysis", *Monograph Series*, 6 (Washington, The Institute of Languages and Linguistics, 1954), pp. 7-18.

<sup>3</sup> The author would like especially to acknowledge Professors Kenneth Moll and James Lubker who assisted in the preparation of the films.

Film No. 621-1 includes vowels in isolation and plain vs. pharyngealized consonants — first recorded in consonant-vowel sequences and then as lexical items in minimal pairs in initial, medial and final positions and geminated.

Film No. 621-2 contains the back consonants (velar, uvular, pharyngeal and laryngeal) recorded in the same manner as the consonants in Film No. 621-1.

Certain frames were chosen from each film for illustrative purposes and tracings were made of these frames. These tracings appear throughout the book. No detailed analysis of the films has been made at this time, but the author plans to make a further and thorough investigation of the data at a later date.

### C. EQUIPMENT USED IN MAKING THE FILMS

The equipment used in the filming of the material was designed by the North American Phillips Company. It consists of the following basic components: a Rotalix 0-75/125 x-ray tube with a 0.6 mm<sup>2</sup> focal spot, a 300 ma generator, a smoothing capacitor, and a nine-inch image intensifier tube with an intensification factor of approximately 3000. The light emitted from the intensifier tube may be directed through a lens system to either a fluoroscopic viewer or to the lens of a motion picture camera.

The films are very clear and cover the laryngeal, pharyngeal and vocal cavities. For synchronization purposes, the sound that accompanies the films is about 26 frames ahead of the picture. It takes about five minutes to project both films continuously. At the beginning of film No. 621-1, when projected, black dots appear on the front part of the mouth — above the tongue. Each dot measures about 1/4 inch in diameter. These dots may be used to measure the actual size of the speaker's mouth. The tongue was painted with barium, as far back as possible, in order to show the movements clearly.

### D. INFORMANTS

The primary informant for this work was the author. The other informants, mostly from the north, center and south of Iraq were: Mr. Jabir Abbas, Mr. Shaiban al-Shaibani, Mr. and Mrs. al-Khatib, Mr. A. M. al-Mahmood, Mr. M. Khalil and Mr. Salim H. T. al-Ani. Two informants from Jordan were also used only for the pharyngealized consonants. These were Mr. A. Mukhlis and Mr. Mishaymish. All of the informants listed have college degrees and are between the ages of 25 and 35.

## II

### THE VOWELS

The phonetic description of the Arabic vowels is based on articulatory data supported by X-ray tracings, impressionistic judgements, and spectrographic displays. By using the technical methods it was possible to make a valid phonetic description, which is necessary before attempting the phonemic level of description.

There are three short vowels in Arabic, /i/, /u/, and /a/, which contrast phonemically with their long counterparts, /ii/, /uu/, and /aa/. (Throughout the text, phonemic length is indicated by writing the vowel symbol twice.)

The vowels were recorded in the following ways: in isolation, within the consonant-vowel sequences (which form grammatical sequences in the language), as lexical items in minimal pairs, and in short phrases and sentences.

In this chapter emphasis is directed to the vowels in isolation. These vowels were recorded as citation forms in order to have steady-state formants without consonant-vowel transitions. However, it is observed that almost all vowels in isolation seem to have some sort of abrupt initiation (the amount of which varies from one vowel to another). Almost all vowels, when recorded, are initiated with a glottal stop. Such an initial glottal articulation seems reasonable since all words in Arabic begin with a consonant. Also, those words in Arabic which are normally considered to begin with a vowel usually are initiated with a glottal stop before the vowel.

It is also observed that the relative durations of the vowels are almost twice as long when in isolation as when they are in speech sequences. The long vowels seem to be twice the length of the short vowels in either setting. This is probably because these vowels are normally stressed and carefully spoken.

It is noticed that the vowel displays seem to indicate a little breathiness at the very end of the spectrograms particularly after F<sub>2</sub> and F<sub>3</sub>, i.e., in the higher frequencies.

The following chart shows the time measurements which indicate the relative durations, in msec, between short and long vowels, when spoken by the author.<sup>1</sup>

<sup>1</sup> My appreciation and thanks are extended to Drs. Gordon E. Peterson and June E. Shoup for carefully checking the vowel measurements with me.

It also lists the formant frequency measurements in cps. Supporting spectrographic data are shown in Figure 1, page 26.

CHART I  
*Relative Durations of Vowels in Isolation*

<i>Vowel</i>	<i>Duration</i>	<i>F<sub>1</sub></i>	<i>F<sub>2</sub></i>	<i>F<sub>3</sub></i>
i	300	290	2200	2700
ii	600	285	2200	2700
u	300	290	800	2150
uu	600	285	775	2050
a	300	600	1500	2100
aa	600	675	1200	2150

A. ALLOPHONES OF VOWELS

The allophonic environments of both short and long vowels seem to vary a great deal. The higher vowels, both back and front, have relatively less allophonic variations. This is especially true with / u / and / uu /.

Each vowel is introduced below with its allophones. The acoustic characteristics and the physiological features of the allophones are discussed in the chapters that follow.

/ i /      The most common allophone is a<sup>2</sup> short high front unrounded vowel. The phoneme has three allophones altogether:

- [ i ]

centralized and slightly low when in the neighborhood of pharyngealized consonants except / l /.
- / i / =

[ I ]      next to / ε / and / γ /
- [ i ]      elsewhere

/ ii /      The most common allophone is a long high front unrounded vowel. Like its short counterpart, / i /, the phoneme has three allophones:

- [ ii ]

centralized and slightly low when in the neighborhood of pharyngealized consonants except / l /.
- / ii / =

[ II ]      next to / ε / and / γ /
- [ ii ]      elsewhere

<sup>2</sup> The author is grateful to Drs. Peterson and Shoup for their suggestion to use the phrase “The most common allophone is a...”.

- / u /      The most common allophone is a short high back rounded vowel. The phoneme has two allophones:
- |         |       |  |
|---------|-------|--|
| / u / = | [ ʊ ] | next to pharyngealized consonants except / ɭ / |
|         | [ u ] | elsewhere                                      |
- / uu /      The most common allophone is a long high back rounded vowel. This phoneme also has two allophones:
- |          |        |  |
|----------|--------|--|
| / uu / = | [ ʊʊ ] | next to pharyngealized consonants except / ɭ / |
|          | [ uu ] | elsewhere                                      |
- / a /      The most common allophone is a low short central unrounded vowel. The phoneme has four allophones:
- |         |       |   |
|---------|-------|---|
|         | [ ə ] | when final and not next to non-pharyngealized consonants or / q /, / ε /, / r / and / γ / |
| / a / = | [ α ] | next to pharyngealized consonants and / q / and / r /                                     |
|         | [ ʌ ] | next to / ε / and / γ /   |
|         | [ a ] | elsewhere   |
- / aa /      The most common allophone is a low long central unrounded vowel. The phoneme has three allophones:
- |          |        |   |
|----------|--------|---|
|          | [ αα ] | next to pharyngealized consonants and / q / and / r / |
| / aa / = | [ ʌʌ ] | next to / ε / and / γ /                               |
|          | [ aa ] | elsewhere   |

## B. VOWEL PLOTS

F<sub>1</sub> and F<sub>2</sub> of both short and long vowels were measured as pronounced by the author. Diagram I indicates the locations of the vowels according to their formant measurements. Each vowel is shown at the intersection of the readings of F<sub>1</sub> and F<sub>2</sub>. It appears that with / a / and / aa / there is not only a quantity difference but a substantial quality difference as well.

## C. FILM TRACINGS

The six vowels were also examined physiologically, in isolation, and tracings of the position of the tongue with each vowel were made.<sup>3</sup> Each short vowel and its long

<sup>3</sup> Special acknowledgement is due Dr. Kenneth Moll of The University of Iowa for his excellent work on the tracings presented here and in the following chapters.



counterpart is placed on one tracing. The broken line indicates the short vowel and the solid line the long vowel. It is observed from these tracings that there is little difference between the long and short counterparts of high front, / i / and / ii /, and of high back, / u / and / uu /, vowels. However, a difference exists between the low central vowels, / a / and / aa /. The tongue position with / aa / seems lower and somewhat more retracted than with / a /. See tracings 2, 3, and 4 on pages 27 and 28.

It is interesting to note that the the correlation between the acoustical and the physiological results agree. This can be seen if one compares Diagram I, below and Tracings 2, 3, and 4, on pages 27-28.

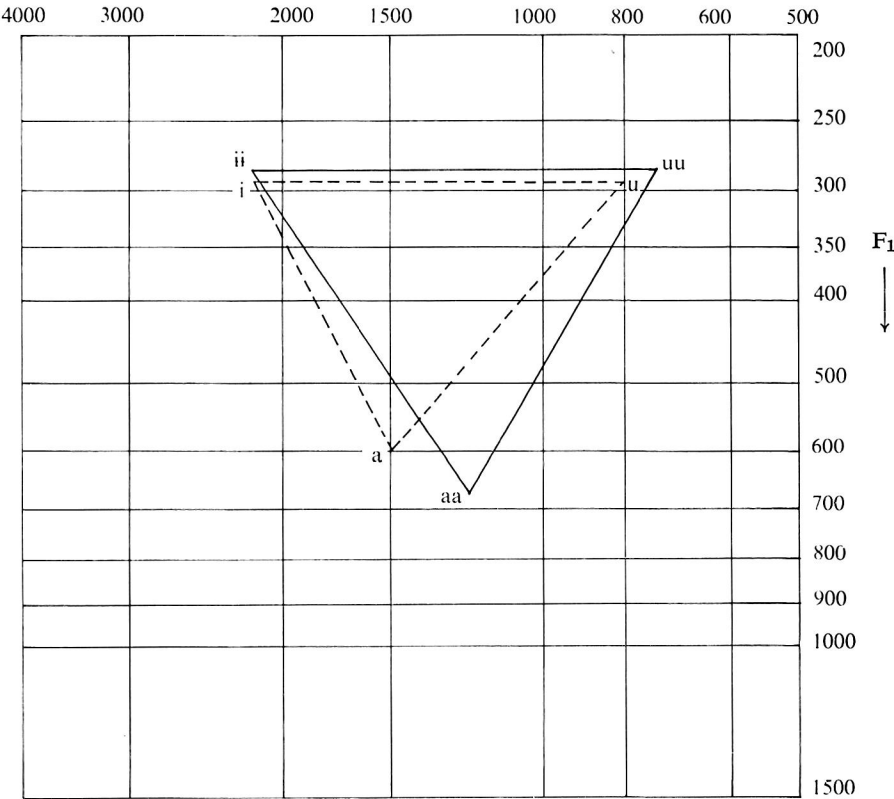


DIAGRAM I

*Short and Long Vowels in Isolation*  
← F<sub>2</sub>

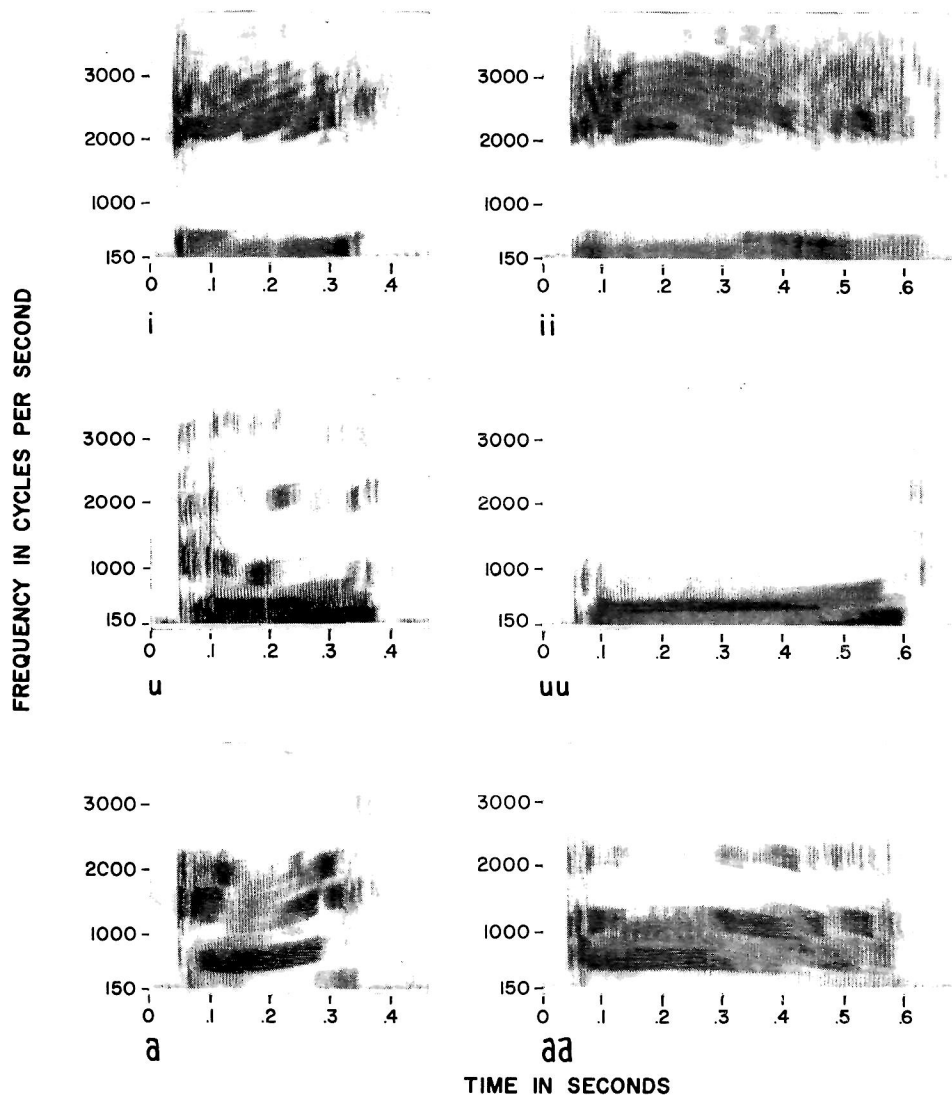
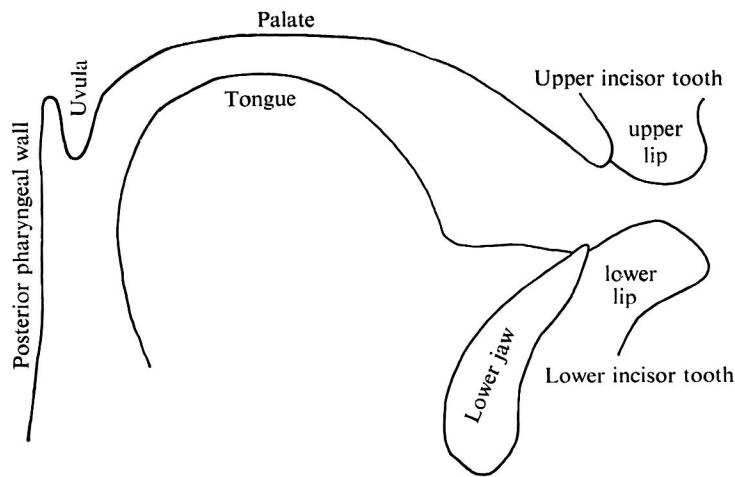
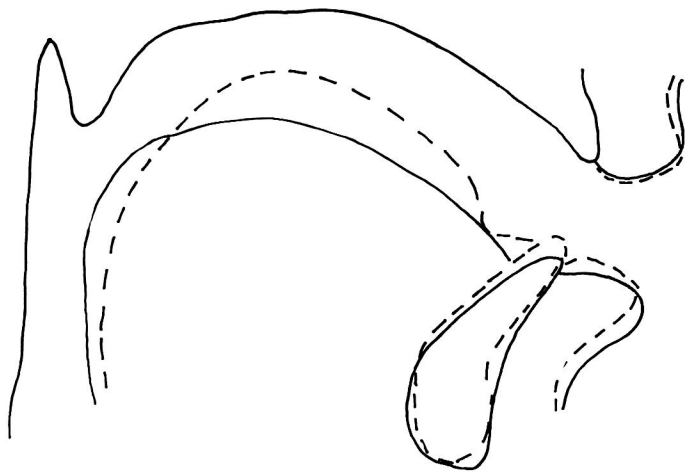


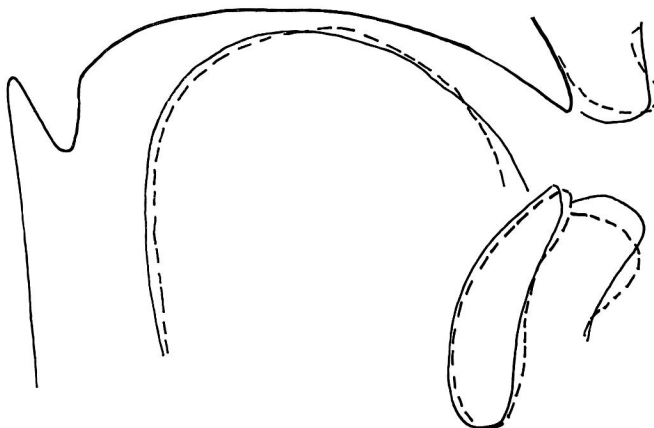
FIG. 1



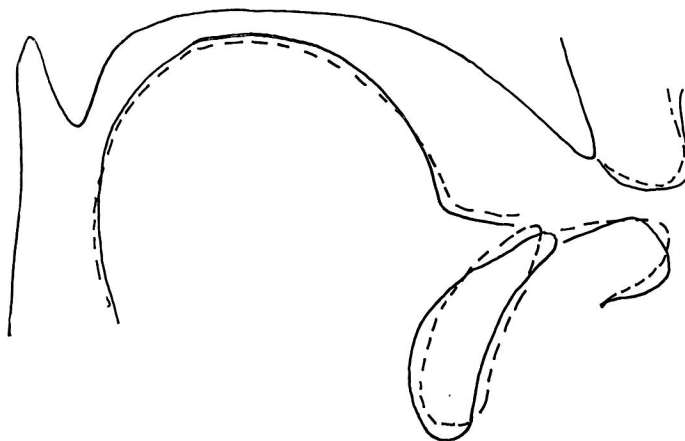
Tracing No. 1: *Identification Template*



Tracing No. 2: / a / -----  
/ aa / —————



Tracing No. 3: /i/ -----  
                  /ii/ —————



Tracing No. 4: /u/ -----  
                  /uu/ —————

### III

## THE CONSONANTS

Arabic contains 29 consonant phonemes. They are listed on the chart below which is based on physiological speech parameters that consist of both horizontal and vertical places of articulation with various manners of articulation superimposed.<sup>1</sup>

CHART II  
*The Consonants*

		Horizontal Place of Articulation							Vertical Place of Articulation
		Bilabial	Labiodental	Interdental	Dental	Palatal	Velar	Uvular	
Nasals		m			n				
Stops	vl.				t    ṭ		k	q	
	vd.	b			d    *ḏ	ʕ			
Trill					r				
Fricatives	vl.		f	θ	s    ṣ	ʃ	x		
	vd.			ð    ḏ	z			γ	
Sonorants		w			l    ḷ	y			
<div> <div>*ḏ occurs only in the colloquial speech of the Christain Arabs in Iraq.</div> <div> <div>h    ʕ    Pharyngeal</div> <div>h    ʔ    Glottal</div> </div> </div>									

<sup>1</sup> This chart is adopted, with modification, from: Gordon E. Peterson, and June E. Shoup, “A Physiological Theory of Phonetics”, *Journal of Speech and Hearing Research*, 9:1.45, 1966.

Whenever a pharyngealized consonant occurs within a syllable the whole syllable, phonetically, is pharyngealized. This potentially makes all of the phonemes allophonically conditioned in this environment. Therefore, to avoid repetition, it is understood that each consonant has this one allophone. Accordingly, it will not be listed with the description of each consonant. Any additional allophones will be described when necessary.

Also, the phenomenon of pharyngealization is not confined to the syllable boundary but may or may not have an influence on the neighboring syllable. This puts the immediate consonantal phonemes, preceding and following, in free variation — pharyngealized or non-pharyngealized.

Voiced consonants in final position are in free variation — voiced or voiceless, and voiceless consonants, intervocalically, are also in free variation — voiced or voiceless.

#### A. ACOUSTIC CHARACTERISTICS

Generally, consonants have less acoustic energy than vowels. The characteristics that form a vowel are relatively more prominent and stable than those of the consonants. The consonants vary individually, making it easier to deal with them in groups, i.e., nasals, stops, etc.

The consonants are described below, excluding the pharyngealized consonants with their plain counterparts (see Chapter IV) and the pharyngeals and glottals (see Chapter V).

##### 1. *Nasals*

The nasality feature is defined in physiological terms as “The formation of one or more oral closures as air flows through the nose”.<sup>2</sup> In the production of the nasals, two cavities are normally used — oral and nasal. It is this unique combination that distinguishes nasals from other groups; fricatives, stops, etc.

Acoustically this combination, oral and nasal, when voiced usually appears on the spectrograms as “a voice bar along the baseline, which differentiates the nasals from the vowels and other vowel-like sounds”.<sup>3</sup>

There are two nasals in Arabic, / m / and / n /, described as follows:

/ m /      The most common allophone of this phoneme is a voiced bilabial nasal — duration 70-90 msec. It possesses weak resonances that appear as

<sup>2</sup> Peterson and Shoup, *Ibid.*, p. 52.

<sup>3</sup> Ralph K. Potter, George A. Kopp, and Harriet C. Green, *Visible Speech* (New York, D. Van Nostrand Company, Inc., 1947), p. 166.

formant structures: along the baseline  $F_1 = 250$  cps,  $F_2 = 1000$  cps and  $F_3 = 2700$  cps. In addition to these formant structures, the / m / is characterized by much weaker resonances (not always present) just above  $F_1$  appearing horizontally.

The / m / demonstrates an influence on the high front vowels, / i / and / ii /, by lowering their second formant onsets to 1850 cps. No special influence is shown on the high back vowels, / u / and / uu /. However, in a few cases, the onset of the second formant of the low central vowels, / a / and / aa /, is slightly lowered. As one would expect, / m / seems to be similar to / b / except for its nasal quality which is characterized by a very weak pattern of nasal formant structures.

/ n / The most common allophone of this phoneme is a voiced dental nasal — duration 80-100 msec. Like the / m / it possesses weak resonances that appear as slight formant structures: along the baseline  $F_1 = 250$  cps,  $F_2$ , which usually has higher frequencies than the / m /, = 1500-1600 cps and  $F_3$ , which is similar to that for / m /, = about 2800-3000 cps.

Generally / n / exerts an influence on the high back vowels, / u / and / uu /, and raises their onsets of  $F_2$  to 1300-1400 cps from their usual steady-states of 750-800 cps. The high front vowels, / i / and / ii /, are also slightly influenced by a lowering of their  $F_2$  onsets to 1950 cps. No noticeable influence of any importance is observed with / a / and / aa /, except that the  $F_2$  onset of / aa /, in a few cases, is very slightly raised. The reason for this is that the  $F_2$  of / n / assumes a similar range of frequencies as for / a / and / aa /.

## 2. Stops

Stops are physiologically characterized by two features: (1) the formation of a closure within the vocal cavity by one or more articulators where the driving pressure is blocked and (2) by the sudden release of that pressure.

The build up of driving pressure appears on the spectrograms as a gap for voiceless stops. The voiced stop is indicated by the voice bar along the baseline. The sudden release appears as a burst.<sup>4</sup>

/ b / The most common allophone is a voiced bilabial unaspirated stop. In final position / b / is in free variation — voiced or voiceless, released or unreleased. The voicing of the / b / appears on the spectrograms along the baseline at about 250 cps, with a duration of from 60-110 msec. It also has a low  $F_2$ , 1100 cps, which influences the onsets of / i / and / ii / by lowering them to 1600-1700 cps. The onsets of the second formants

<sup>4</sup> For additional information on stops see: Peterson and Shoup, *op. cit.*, p. 51, and Leigh Lisker, and Arthur S. Abramson, "A Cross-Language Study of Voicing in Initial Stops: Acoustical Measurements", *Word* (The Linguistic Circle of New York, 1964), Vol. 20, p. 384.

of / a / and / aa / are only slightly affected and the / u / and / uu / are not affected at all.

/ ʒ / The most common allophones form a voiced palatal affricate. In final position it is in free variation, either voiced or voiceless. Phonetically, the / ʒ / is a combination of two phones, [ d ] and [ z ].<sup>5</sup> This combination — a stop and a fricative — also appears on the spectrograms as a stop followed by a voiced fricative. Initially, the [ d ] appears as a voice bar with no noise directly above it. The [ d ] may or may not have a burst and is immediately followed by a random noise in the upper frequencies, 2500 cps and up, with a continuation of the voice bar of the [ d ]. The [ z ] seems to have an immediate influence on / u / and / uu / which is indicated by rising transitions of the onsets of F<sub>2</sub> to about 1350 cps. The [ z ] seems to have no important affect on the other vowels. The duration of / ʒ / is from 120-180 msec. The [ d ] usually takes about one-third or less of this duration. The / ʒ / is shown in Figure 2, page 36.

/ k / The most common allophone is a velar voiceless aspirated stop, but a palatalized allophone [ k' ] occurs next to / i / and / ii /. The / k / appears on the spectrograms as a burst — random noise duration 60-80 msec — which is indicated by a spike followed by a frictional noise. With / i / and / ii / the concentration of the burst ranges from 2500-3000 cps. A few weak frequencies appear below 2000 cps. With / u / and / uu / the burst concentration is 1000 cps and the burst and noise disappear above 1200 cps. With / a / and / aa / the burst concentration is between 2000 and 2200 cps.

/ q / The most common allophone is a uvular voiceless unaspirated stop that appears as a strong burst which is indicated by a vertical spike that starts (weakly) at the baseline and rises to 3000 cps. This is followed by a silence gap with an average duration of 30-40 msec, with no noise following the spike. This indicates a lack of aspiration.

In examining the vowel formants next to / k / and / q /, it is observed that the / q / exerts an influence on the onsets of F<sub>2</sub> of / i / and / ii / and lowers them to 1600 cps from their steady-state positions of 2250 and 2200 cps, respectively. The onsets of F<sub>2</sub> of / i / and / ii / next to / k / are slightly lowered to 2000 cps. It is also observed that the onsets of F<sub>1</sub> of / i / and / ii / are slightly raised under the influence of the / q /.

The onsets of F<sub>2</sub> of / u / and / uu / with / q / are slightly raised to 900 cps. The / u / and / uu / are not affected by the / k /.

<sup>5</sup> Truby, *op. cit.*, p. 400.



With / a /, the / q / produces a very low  $F_2$  onset, around 1200 cps, as compared to that for / k / which is around 1500-1600 cps.

With / aa /, the / k / produces a higher  $F_2$  onset than that of the / q /, around 1350 cps. The  $F_2$  onset resulting from the / q / is about 1150 cps.

Medially, the relative duration of the silence gap of the closure with / k / or / q / is about 150 msec and with / kk / or / qq /, 300 msec.

In final position, both / k / and / q / are released or unreleased. When released, the release is indicated by a weak spike that is preceded by a gap of about 200 msec in duration. The release of the / k / is accompanied by slight aspiration appearing as noise. This is lacking with the / q /. The / k / and / q / are indicated in Figures 3, 4, and 5, pages 36-37 and in Tracings 5 through 10, pages 41-43.

### 3. *Trill*

/ r / The most common allophone is a voiced dental trill which is pharyngealized not only when it occurs next to pharyngealized consonants but whenever it is in the vicinity of / a / or / aa / as well. Its duration is from 80-100 msec. The / r / possesses distinct formant structures which are interrupted by a vertical short gap with a duration of about 15 msec. This gap appears, vertically, in the middle of the resonances and can be interpreted, physiologically, as a result of a tap by the tip of the tongue against the hard palate where energy is being cut-off. In most cases, only one gap is observed but occasionally more than one appears. With all of the vowels  $F_1$  of the / r / is the same, about 260 cps along the baseline; with / i / and / ii / and / u / and / uu /  $F_2$  is around 1500 cps; with / a / and / aa /  $F_2$  is around 1200-1250 cps. The / r / possesses similar formant structures to those of the / l / except that  $F_2$  and particularly  $F_3$  of the / r / are lower.

The / r / exerts an influence on / i / and / ii / by lowering the onsets of  $F_2$  to 1700 cps from 2150 cps. The onsets of  $F_3$  are also lowered. With / u / and / uu / the onsets of  $F_2$  are raised to about 1050 cps from their usual steady-states of 800 cps. With / a /  $F_2$  is around 1300 cps and with / aa / around 1200 cps.

### 4. *Fricatives*

Fricatives are produced in the vocal cavity by a narrow constriction that causes the airflow to be consistently turbulent. Acoustically, voiceless fricatives usually possess a high random noise and voiced fricatives usually possess weak resonance structures appearing as a shadow of weak formants with little noise intervening. The strongest of these formant structures, indicating the voicing, appears along the baseline.

The fricatives and their descriptions are as follows:

- /f/ The most common allophone of this phoneme is a labiodental voiceless fricative that appears as a random noise — duration varies from 80-140 msec. The noise starts from about 1600 cps and up.
- /θ/ The most common allophone of this phoneme is a voiceless interdental fricative that appears as a random noise — duration 80-130 msec — weaker than with the /f/.

The /f/ and /θ/ slightly lower the onsets of  $F_2$  of /i/ and /ii/ to 1900-2000 cps and raise the onsets of  $F_2$  of /u/ and /uu/ to 1300 cps from their usual steady-states of 750-800 cps. The  $F_2$  onsets of /a/ next to /f/ and /θ/ are about 1500 cps and the  $F_2$  onsets of /aa/ are about 1350 cps. These are the usual locations of  $F_2$  of the vowels with non-pharyngealized consonants.

- /z/ The most common allophone of this phoneme is a voiced dental fricative that seems to possess three formants —  $F_1$ , along the baseline, 250 cps,  $F_2$ , 1600 cps and  $F_3$ , 2400 cps. In the upper frequencies /z/ contains random noise — range 3000 cps up to the top of the spectrum — with a relative duration of between 100 and 160 msec. It influences the onsets of  $F_2$  of /u/ and /uu/ and raises them to 1350-1400 cps from their usual steady-states of around 750-800 cps. With /i/ and /ii/ the onsets of  $F_2$  are slightly lowered to about 2000 cps from their usual steady-states of 2200 cps. With /a/ the onsets of  $F_2$  with /z/ are about 1500 cps and with /aa/ about 1350 cps.
- /ʃ/ The most common allophone is a voiceless palatal fricative that appears as a random noise — relative duration 120-170 msec — in the upper frequencies of the spectrum. The noise starts at about 2000 cps with /i/ and /ii/, at 1500 cps with /u/ and /uu/ and at 1700 cps with /a/ and /aa/. The /ʃ/ possesses a higher frequency random noise spectrum than most of the other fricatives. The influence of /ʃ/ on the neighboring vowels is like that of the /z/.
- /x/ The most common allophone is a voiceless velar fricative that appears as a random noise that is concentrated, with /i/ and /ii/, in the upper frequencies between 2000-3000 cps. This noise is lacking below 1500 cps. The noise concentration with /u/ and /uu/ is from 1000 cps up to the higher frequencies and is lacking below 800 cps. With /a/ and /aa/, the noise concentration is from 1500 cps up and is lacking below 1000 cps. The relative duration of /x/ is from 100 to 160 msec.
- /ɣ/ There are two common allophones of this phoneme. Both are voiced fricatives — one is uvular next to /u/ and /uu/ and /a/ and /aa/

and the other is velar next to /i/ and /ii/. The /γ/ appears on the spectrograms as a shadow of formant resonances, near the baseline, that are a continuation of F<sub>1</sub>, F<sub>2</sub>, and F<sub>3</sub>. Occasionally, it has a very weak noise above F<sub>3</sub>. The duration is similar to that of /x/.

Next to /i/ and /ii/ and /u/ and /uu/ the /x/ and /γ/ seem to have similar vowel formant frequencies. Next to /i/ and /ii/ the onsets of F<sub>2</sub> are lowered to 1800-1900 cps, next to /u/ and /uu/ the onsets of F<sub>2</sub> are raised slightly to 1350 cps. With /x/ and /γ/ the onsets of F<sub>1</sub> and F<sub>3</sub> of /a/ are similar. When /a/ is next to /x/ the onset of F<sub>2</sub> is 1500 cps and when it is next to /γ/ the onset of F<sub>2</sub> is 1300 cps. With /aa/, F<sub>1</sub> and F<sub>3</sub> are similar. When /aa/ is next to /x/ the onset of F<sub>2</sub> is 1350 cps and when next to /γ/ the F<sub>2</sub> onset is 1250 cps. See Figures 6, 7, 8, pages 38-40.

### 5. *Sonorants*

The sonorants possess more acoustic characteristics similar to those of the vowels than any of the other consonantal groups. There are four sonorants, /l/, /l̥/, /w/ and /y/. The /l/ and /l̥/ are explained in Chapter IV and the /w/ and /y/ are explained below.

/w/      The most common allophone is a bilabial sonorant — duration 80-100 msec. It possesses distinct vowel-like formant structures similar to those of the /u/ and /uu/ — F<sub>1</sub>, along the baseline, 285 cps, F<sub>2</sub>, 850 cps and F<sub>3</sub>, 2100 cps. The onsets and offsets of F<sub>2</sub> of /w/ usually glide into the preceding and following phones. The /w/ forms a diphthong with /a/ — /aw/.

/y/      The most common allophone is a palatal sonorant — duration 80-100 msec. The /y/ possesses distinct vowel-like formant structures similar to those of /i/ and /ii/. F<sub>1</sub>, along the baseline, 275 cps, F<sub>2</sub>, 2100 cps, and F<sub>3</sub>, 2650 cps. Generally, the onsets and offsets of the /y/ glide into the preceding and following phones. The /y/ also forms a diphthong with /a/ — /ay/. The /aw/ and /ay/ are the only two diphthongs in Arabic.

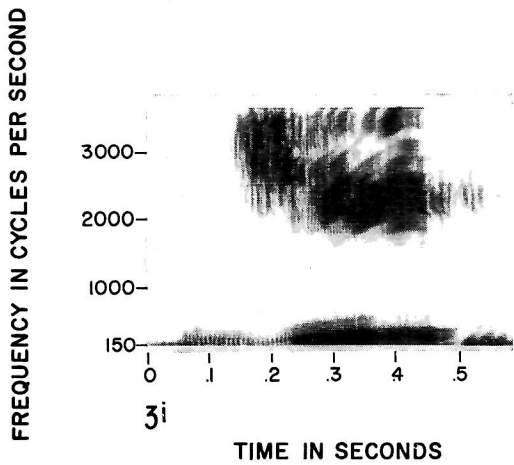


FIG. 2

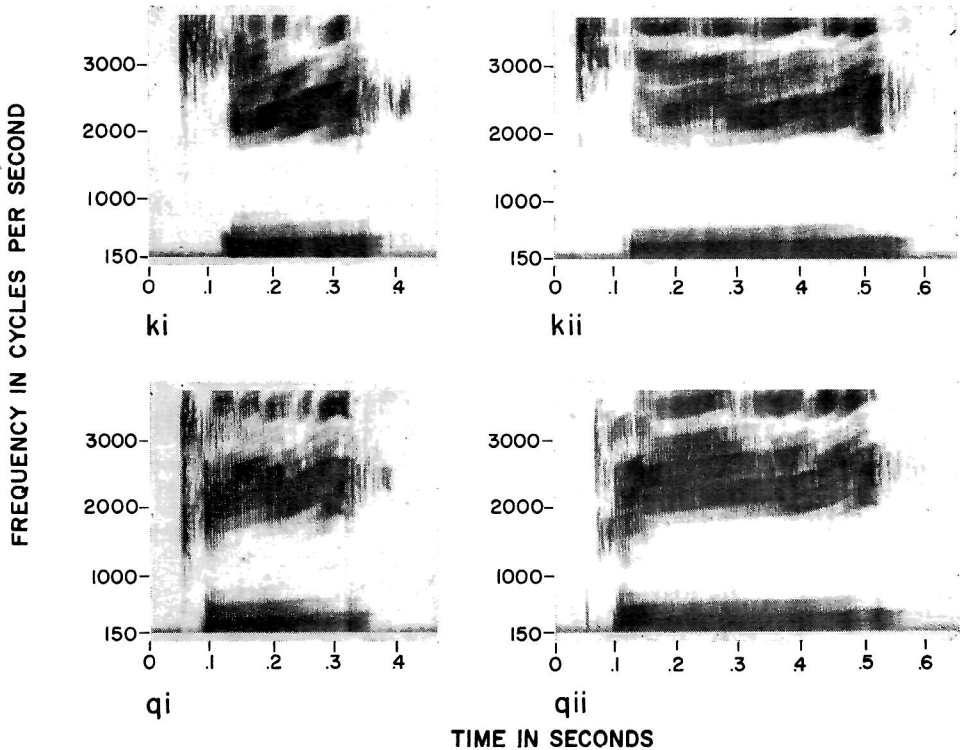
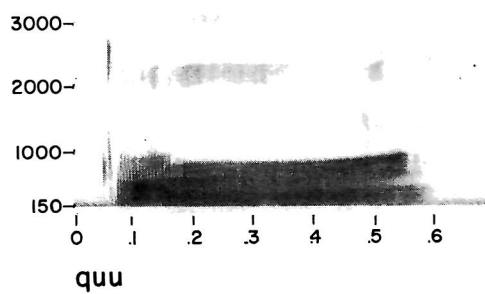
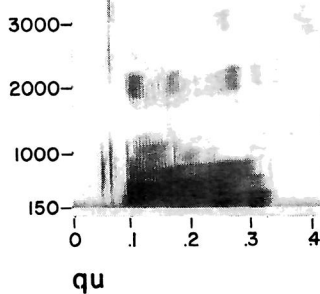
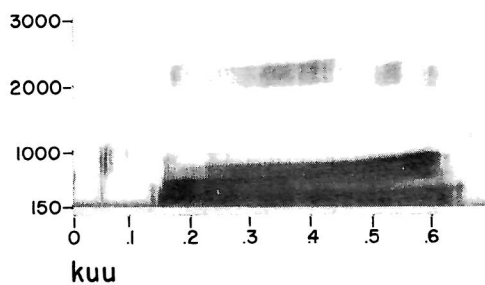
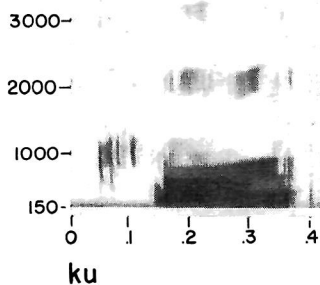


FIG. 3

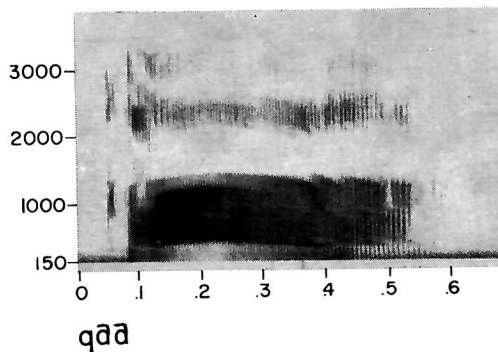
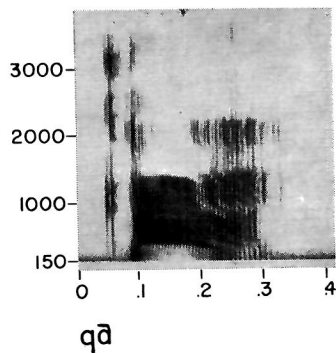
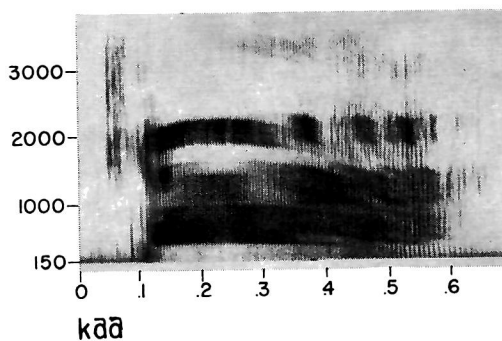
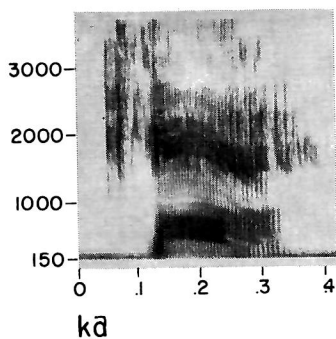
FREQUENCY IN CYCLES PER SECOND



TIME IN SECONDS

FIG. 4

FREQUENCY IN CYCLES PER SECOND



TIME IN SECONDS

FIG. 5

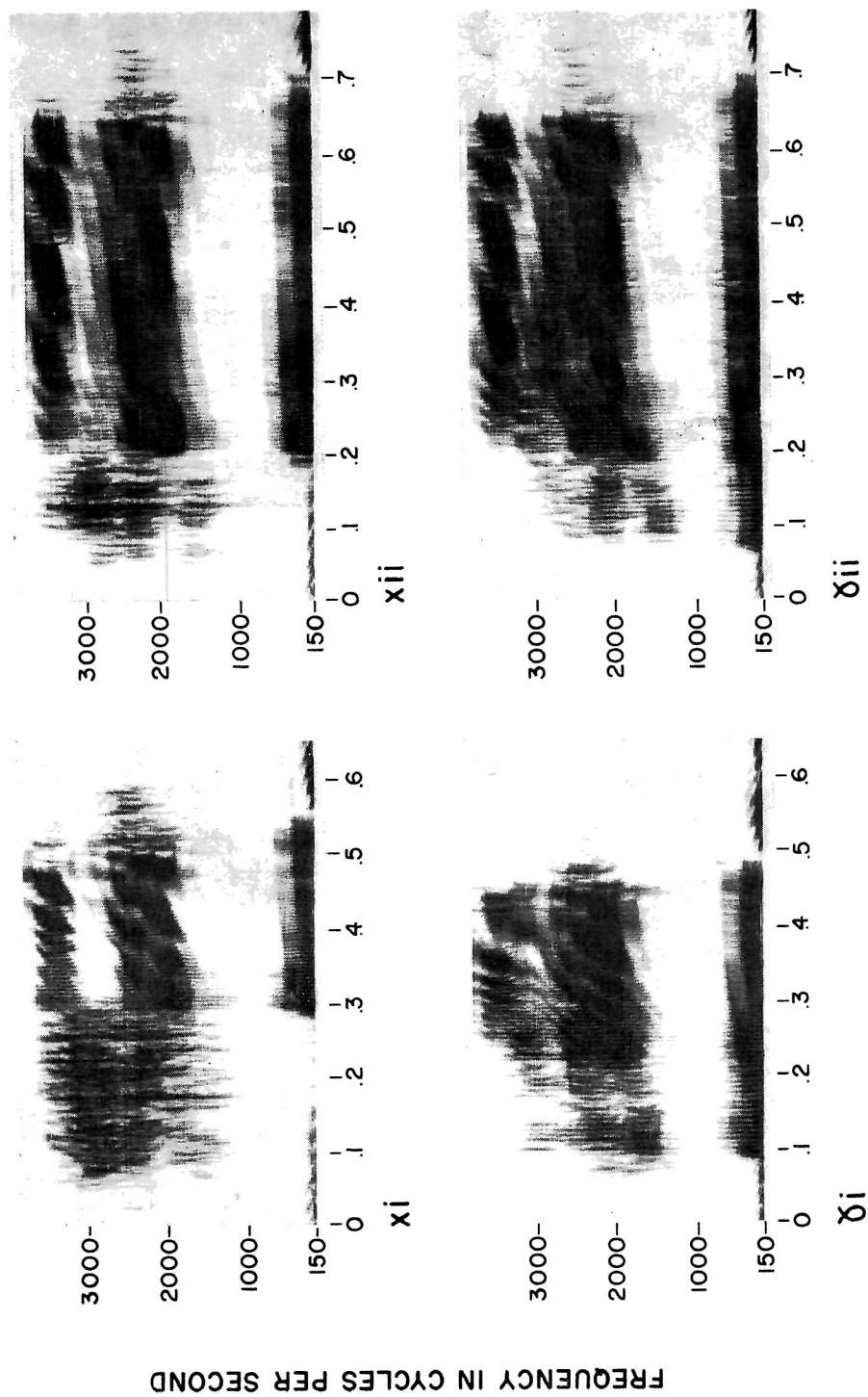


FIG. 6

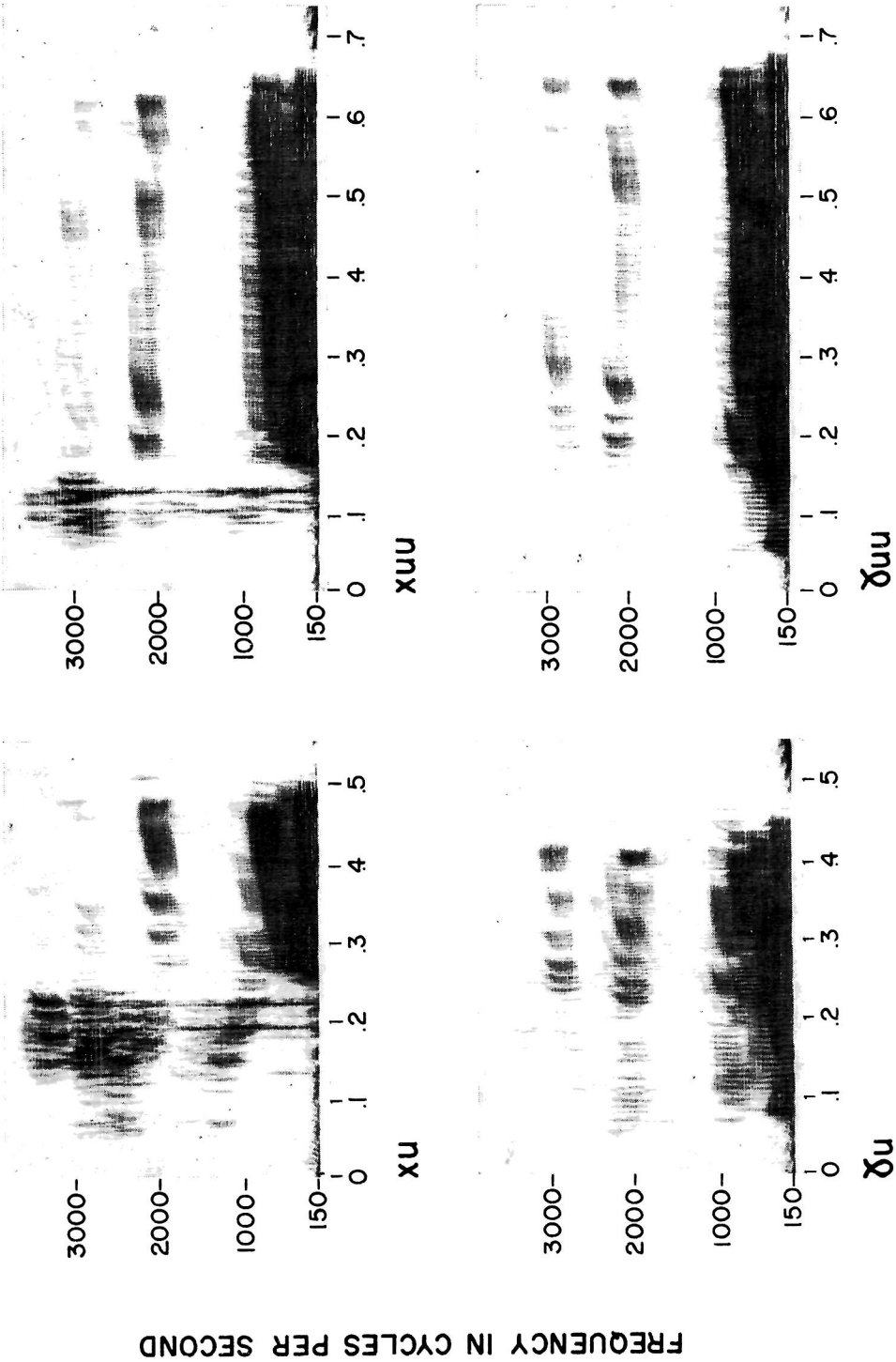


FIG. 7

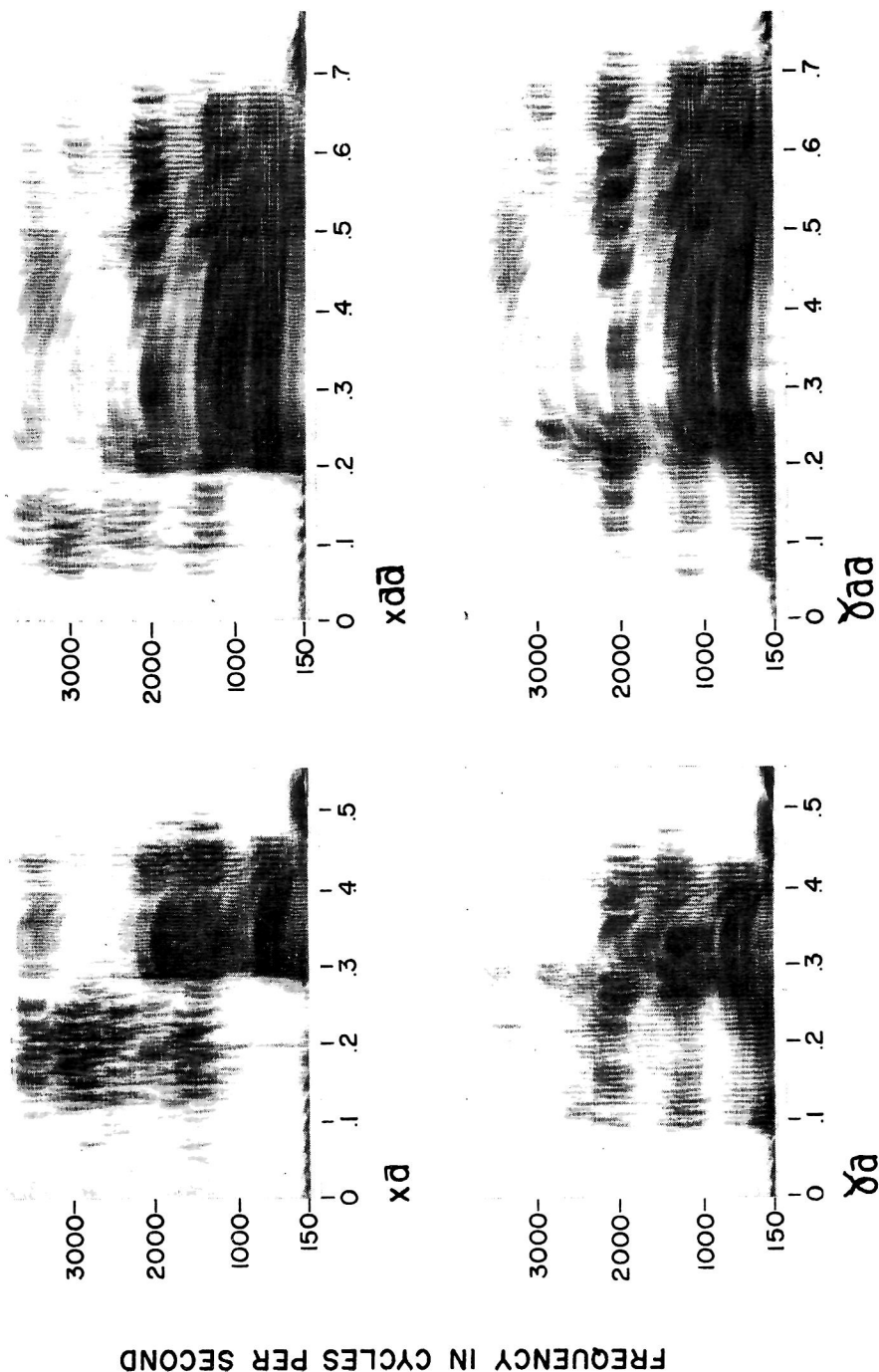
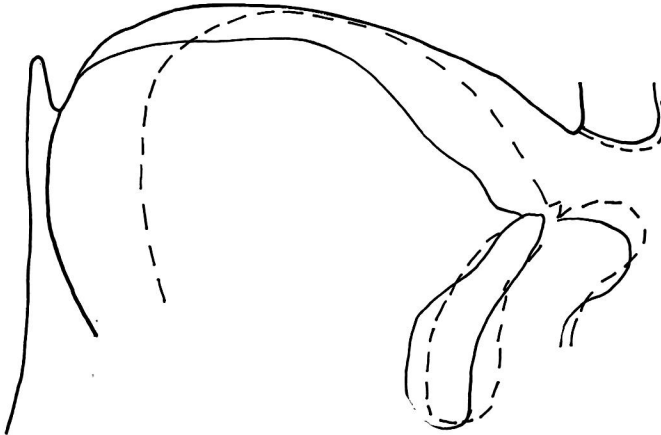
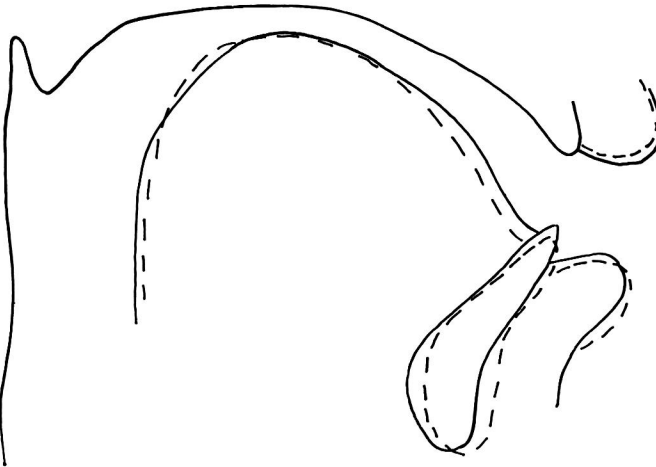


FIG. 8

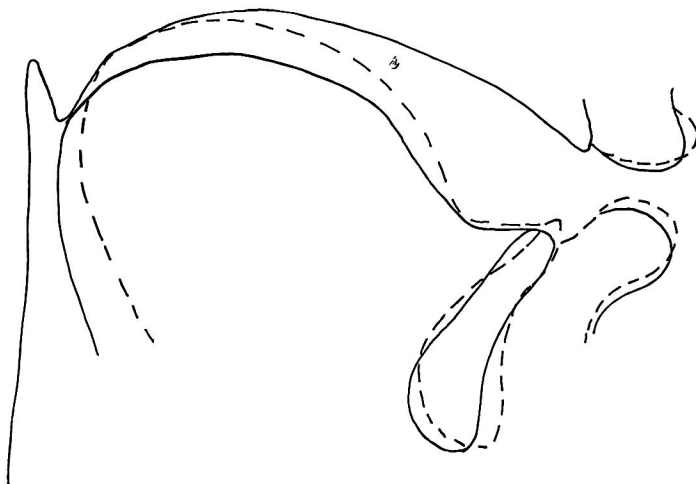




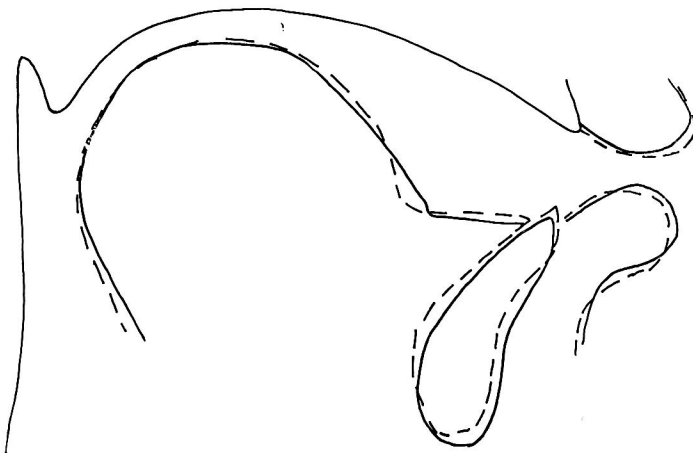
Tracing No. 5: /k/ in /ki/ -----  
/q/ in /qi/ ———



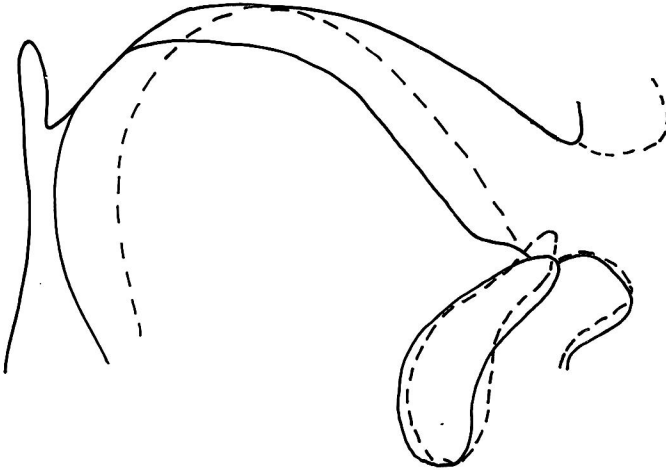
Tracing No. 6: /i/ in /ki/ -----  
/i/ in /qi/ ———



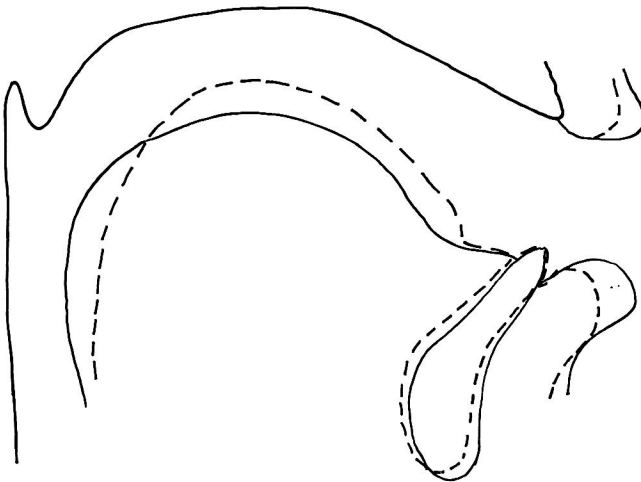
Tracing No. 7: /k/ in /ku/ -----  
                  /q/ in /qu/ ——



Tracing No. 8: /u/ in /ku/ -----  
                  /u/ in /qu/ ——



Tracing No. 9: / k / in / ka / -----  
/ q / in / qa / ———



Tracing No. 10: / a / in / ka / -----  
/ a / in / qa / ———

## IV

### THE PHARYNGEALIZED CONSONANTS

#### A. INTRODUCTION

The phonetic phenomenon that attracted the attention of Arab grammarians as early as the 8th Century or earlier is commonly referred to as 'emphasis'. When the grammarians set up the Arabic alphabet they designated 'emphasis' as a consonantal element rather than vocalic and they posited four certain characters to represent each component. These characters are / t /, / s /, / d /, and / ḏ /. Their number is not the same in all Arabic dialects and in fact most of the dialects embody a larger number than these four.

The term most commonly used in referring to 'emphasis' is velarization. After examining this group of so-called velarized consonants, both acoustically and physiologically, it appears that the area involved is not the velar but rather the pharyngeal. Therefore, it seems more fitting that they be classified as 'pharyngealized' rather than 'velarized'.

It has been found most helpful and effective in the investigation of a certain phonetic feature to relate it to another phonetic entity. With the pharyngealized consonants, each of which has a plain counterpart, I first investigated the plain consonants because they exist in most languages and have been studied before. I then compared (mostly on the acoustic level) the plain vs. the pharyngealized consonants. Accordingly, they are presented in this manner.

The plain vs. pharyngealized consonants were also examined physiologically and tracings were made for each set indicating the positions of the tongue.

#### 1. / t / vs. / t̤ /

/ t /      The most common allophone is a voiceless dental aspirated stop. In final position, / t / is in free variation, either aspirated released or unreleased — mostly released. It appears as a burst — relative duration 40-60 msec, longer with long vowels — in the form of a vertical spike followed by a gap which has weak noise. In final position the relative duration of the

gap before the release is from 150-200 msec. The concentration of the burst with /i/ and /ii/ is in the region of  $F_2$ - $F_3$  between 2000-2800 cps with noise also appearing higher in the region of  $F_4$ ; with /u/ and /uu/ from 1500-2500 cps; and with /a/ and /aa/ from 1600-2700 cps.

The onsets of  $F_2$  of /i/ and /ii/ next to /t/ range from 1900-2000 cps and are slightly lowered from their usual steady-states of 2200 cps. The onsets of  $F_2$  of /u/ and /uu/ next to /t/ rise abruptly to 1400 cps from 750-800 cps which are the usual steady-states.

The onsets and steady-states of  $F_2$  of /a/ next to /t/ are from approximately 1500-1550 cps and for /aa/ next to /t/ they are generally lower, around 1300-1350 cps.

/t̤/

The most common allophone is a voiceless pharyngealized unaspirated post-dental<sup>1</sup> stop. In final position, /t̤/ is in free variation, either released or unreleased — mostly unreleased. It appears as a burst — relative duration 20-30 msec, longer with long vowels — in the form of a vertical spike (stronger than the spike for /t/) followed by a gap with no noticeable noise. In final position, the relative duration of the gap before the release is from 100-180 msec. The concentration of the burst is generally lower in frequency than the burst with the /t/. With /i/ and /ii/ it is in the region of  $F_2$ - $F_3$  between 1700-2400 cps; with /u/ and /uu/ between 1400-2200 cps; and with /a/ and /aa/ between 1500-2400 cps.

Unlike the /i/ and /ii/ when next to /t/ where only  $F_2$  is slightly affected, both  $F_1$  and  $F_2$  of /i/ and /ii/ next to /t̤/ are influenced by a lowering of the onsets of  $F_2$  to about 1100-1300 cps which gradually move upward until the formants reach their steady-states. The /i/ and /ii/ are also influenced by a raising of the onsets of  $F_1$  to about 1000 cps. The transition of  $F_2$  of /i/ takes about one-third of the duration of the vowel, whereas with /ii/ the transition takes about one-fifth of the duration of the vowel.

The onsets of  $F_2$  of /u/ and /uu/ next to /t̤/ rise to 1000 cps from their usual steady-states of 750-800 cps. The rise to 1400 cps with /t/ is higher and much sharper.

When /a/ is next to /t̤/,  $F_2$  is from 1150-1250 cps. This includes the onset and a major part of the steady-state. When /aa/ is next to /t̤/,  $F_2$  is from 1050 to 1150 cps. This makes /a/ and /aa/ uniquely different as not only their onsets are affected but their steady-states as well. See

<sup>1</sup> Post-dental — this term is used to differentiate between the points of articulation of the pharyngealized and non-pharyngealized consonants. The tip of the tongue with the pharyngealized consonants is placed slightly farther back than with the plain. This applies to /t/ vs. /t̤/, /s/ vs. /s̤/, etc.

Figures 9 through 11, pages 51-52 and Tracings 11 through 13, pages 57-58.

2. /d/ vs. /ḍ/

/d/ The most common allophone is a voiced dental unaspirated stop — duration 80-100 msec. In final position it is in free variation, released or unreleased, mostly unreleased. It appears on the spectrograms like the /t/ except for voicing which is indicated for /d/ by the voice bar. Also, the /d/ lacks aspiration. The /d/ like /t/ influences the neighboring vowels in the same manner.

/ḍ/ The most common allophone is a voiced pharyngealized unaspirated post-dental stop — duration 80-100 msec. The /ḍ/ does not occur in Iraq, either on the literary or colloquial levels, except in the dialects of the Arab Christian community. Even though it is represented orthographically as /ḍ/ in the writing system, it is always pronounced as /ḏ/ and not as /ḍ/.<sup>2</sup> Therefore it is not phonemically distinctive, as /ḍ/ is fused with /ḏ/.

/ḍ/	>	/ḏ/
/ḏ/		
/ḍalla/		'he went astray'
/ḏalla/		'he remained'

This minimal pair, which is distinctive in some parts of the Arabic speaking world — such as Egypt — is represented in the writing system by two characters which are homophones in the speech of all of the Iraqi informants.

3. /s/ vs. /ṣ/

/s/ The most common allophone is a voiceless dental sibilant fricative that appears as a random noise — duration 100-170 msec — in the upper frequencies of the spectrum starting at approximately 3000 cps. Occa-

<sup>2</sup> The set /d/ vs. /ḍ/ was tested acoustically by two informants from Jordan who use /ḍ/ naturally in their speech. Also, I examined this set acoustically by imitating the pronunciation of /ḍ/. The results of these experiments seem to agree with the results of the other sets of plain vs. pharyngealized.

sionally, below this noise there appear to be some resonances in the form of very weak formants approaching vowel formants along  $F_2$  at 1600 cps and  $F_3$  at 2400 cps. The influence of /s/ on the neighboring vowels is similar to that of the /z/. The onsets of  $F_2$  of /i/ and /ii/ next to /s/ range from 2000-2100 cps slightly lowered from their usual steady-states of 2200 cps. With /u/ and /uu/ next to /s/, there are sharp transitions of the onsets of  $F_2$  that rise to 1350-1400 cps. The onsets of  $F_2$  of /a/ and /aa/ next to /s/ are not affected as with /i/ and /ii/ and /u/ and /uu/ because the frequencies of  $F_2$  of /s/ and /a/ and /aa/ are in about the same region — ranging from 1500-1600 cps. However, /aa/ is different than /a/ in quantity as well as quality. The whole of  $F_2$  of /aa/ is lower than that of /a/ — between 1300-1400 cps.

/s̤/

The most common allophone is a voiceless pharyngealized post-dental sibilant fricative. It is the counterpart of /s/. The /s̤/ appears as a random noise — duration 100-170 msec — in the upper frequencies of the spectrum starting at approximately 2750 cps. The /s̤/ like /t̤/ influences the neighboring vowels; the onsets of  $F_2$  of /i/ and /ii/ with /s̤/ are lowered to about 1150-1250 cps from their usual steady-states of 2200 cps. This lowering is shown by the transitions that start at about 1150-1250 cps and rise gradually to join the steady-states. The /s̤/ also affects the onsets of  $F_1$  of /i/ and /ii/ which are raised from 300 cps to about 550-650 cps. The influence of /s̤/ on  $F_1$  and  $F_2$  of /i/ is more prominent than with the /ii/. Horizontally, along the time axis, this influence appears to dominate about one-third of the duration of /i/. The onsets of  $F_2$  of /u/ and /uu/ with /s̤/ are gradually raised from 800-1100 cps. The frequencies, per se, of /a/ with /s̤/ are about 1200-1250 cps; with /aa/, 1050-1150 cps. See Figures 12 through 14, pages 53-55.

## 4. /ð/ vs. /ð̤/

/ð̤/

The most common allophone is a voiced interdental fricative — relative duration 100-160 msec — that is easy to detect because it possesses resonances that appear as weak formants;  $F_1$  — along the baseline 275 cps,  $F_2$  — around 1500 cps, and  $F_3$  — 2350 cps. In the space between the formants there is some weak noise. The /ð̤/ influences the onsets of  $F_2$  of /i/ and /ii/ by lowering them to about 1850-1900 cps from their usual steady-states of 2200 cps. The /ð̤/ also seems to influence the onsets of  $F_1$  by raising them slightly. The onsets of  $F_2$  of /u/ and /uu/ with /ð̤/ are raised to 1500 cps from 750-800 cps. The  $F_2$  of /a/ is from 1500-1600 cps and of /aa/ 1350-1450 cps.

/Ǿ/ The most common allophone is a voiced pharyngealized interdental fricative with the same relative duration as /ð/. It also seems to possess resonances that appear as weak formants; F<sub>1</sub> – along the baseline 275 cps, F<sub>2</sub>, 900-1000 cps, and F<sub>3</sub>, 2350 cps. There is also some noise as with the /ð/. The /Ǿ/ influences the onsets of F<sub>2</sub> of /i/ and /ii/ by lowering them to about 1200-1400 cps from their usual steady-states of 2200 cps. The onsets of F<sub>1</sub> are slightly raised. When /u/ and /uu/ are next to /Ǿ/, their onsets of F<sub>2</sub> are raised to 900 cps from their usual steady-states of 750 cps. When /a/ is next to /Ǿ/, the F<sub>2</sub> is 1150-1200 cps and when /aa/ is next to /Ǿ/, the F<sub>2</sub> is from 1050-1150 cps. See Figure 15, on page 56.

### 5. /l/ vs. /l̥/

/l/ The most common allophone is a voiced dental lateral — duration 80-120 msec. The /l/ possesses distinct vowel-like formant structures; F<sub>1</sub>, along the baseline, 250 cps, F<sub>2</sub>, 1500-1600 cps and F<sub>3</sub>, 2400-2500 cps. Generally F<sub>2</sub> of /l/ is a little higher than the F<sub>2</sub> of /r/ (if everything is equal). Therefore, /l/ exerts about the same influence on /i/ and /ii/, lowering the onsets of F<sub>2</sub> to 1850 cps from 2150 cps. However, F<sub>3</sub> does not seem to be affected. With /u/ and /uu/, the onsets of F<sub>2</sub> are raised to about 1300 cps from their usual steady-states of 800 cps. No noticeable influence of any importance is observed with /a/ and /aa/ except that the F<sub>2</sub> onset of /a/, in a few cases, is very slightly raised. The reason for this is that F<sub>2</sub> of /l/ assumes a similar range of frequencies as does the F<sub>2</sub> of /a/ and /aa/.

/l̥/ The most common allophone is a pharyngealized post-dental lateral that occurs in an extremely limited environment — only next to /a/ and /aa/. It is the only phoneme that is not supported orthographically. In the literary language it is only found in the word /ʔallaah/, 'God', and some of its derivatives. In the dialects it is more common.<sup>3</sup> The phonemic contrast between /l/ and /l̥/ is supported by the following minimal pair:

/wallaah/	'by God'
/wallaah/	'he appointed him'

<sup>3</sup> For further information see: Charles A. Ferguson, "The Emphatic /l̥/ in Arabic", *Language*, 32:3. 446-452, 1956.



The /l/ has three distinct formant structures;  $F_1$  – 250 cps,  $F_2$  – 900 cps and  $F_3$  – 2400 cps.  $F_2$  of /a/ next to /l/ is 1250 cps and  $F_2$  of /aa/ next to /l/ is 1150 cps. See Figure 16, on page 56.

### B. FORMANT DIAGRAMS

The vowel frequency measurements of  $F_1$  and  $F_2$  are plotted on the following diagrams which indicate the locations of the vowels according to their measurements. They are plotted both adjacent to pharyngealized and non-pharyngealized consonants.

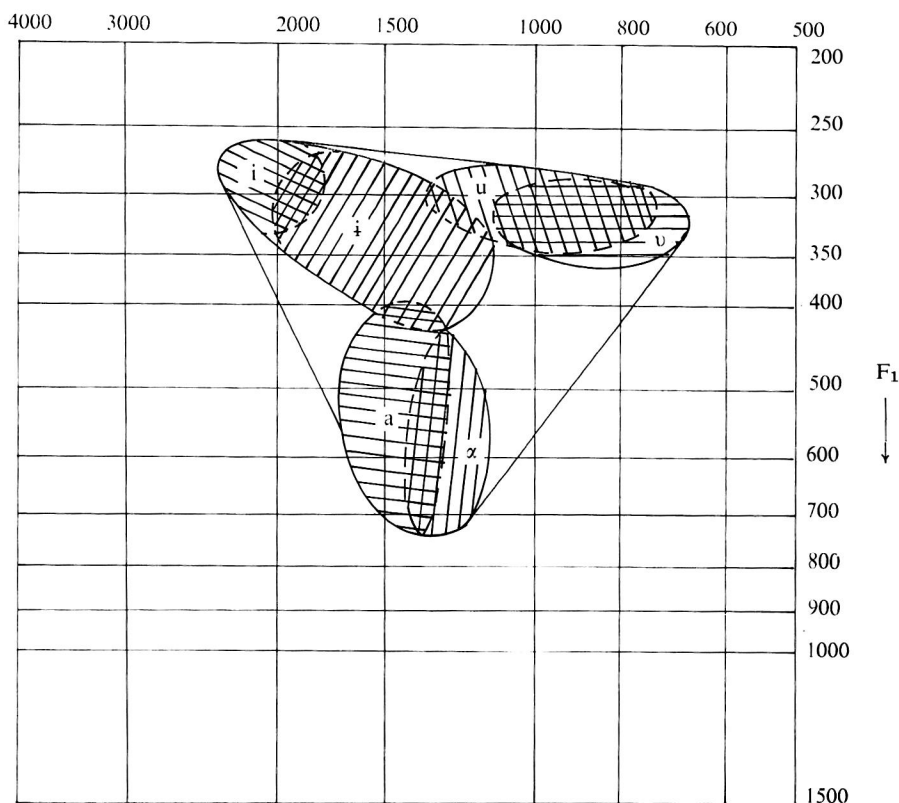


DIAGRAM II  
 $F_2$

*Short Vowels adjacent to Pharyngealized  
and Non-Pharyngealized Consonants in  
overlapping Positions*

## THE PHARYNGEALIZED CONSONANTS

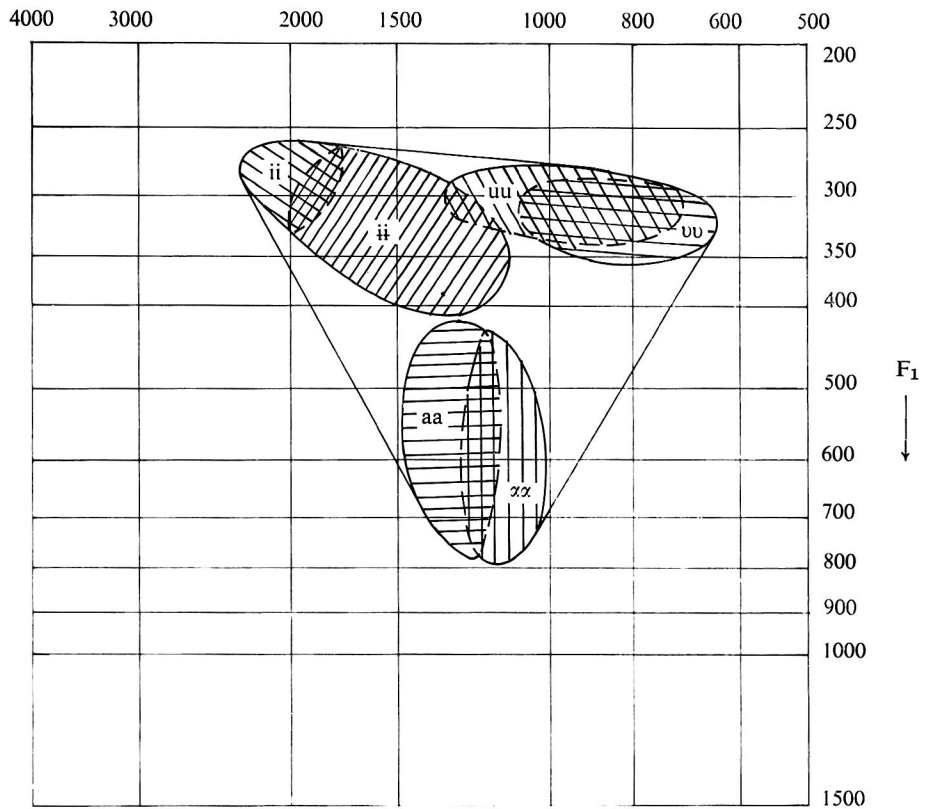


DIAGRAM III  
F<sub>2</sub>

*Long Vowels adjacent to Pharyngealized  
and Non-Pharyngealized Consonants in  
overlapping Positions*

FREQUENCY IN CYCLES PER SECOND

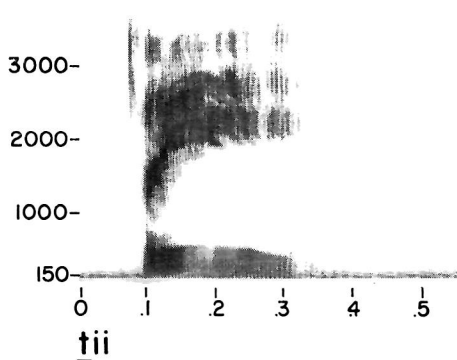
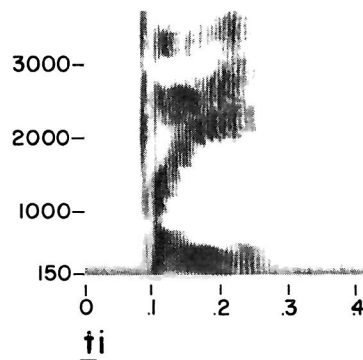
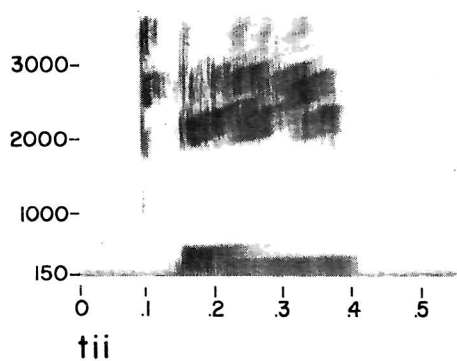
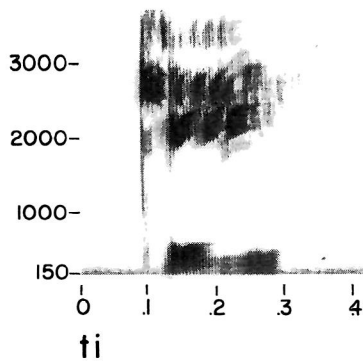


FIG. 9 TIME IN SECONDS

FREQUENCY IN CYCLES PER SECOND

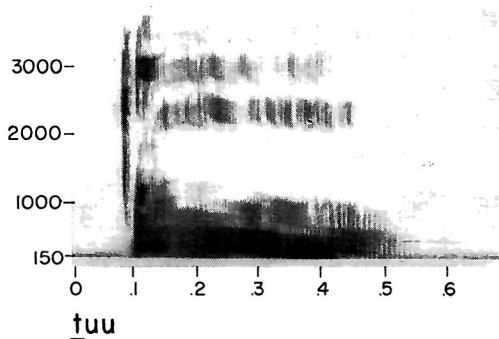
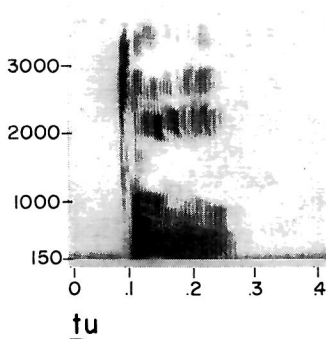
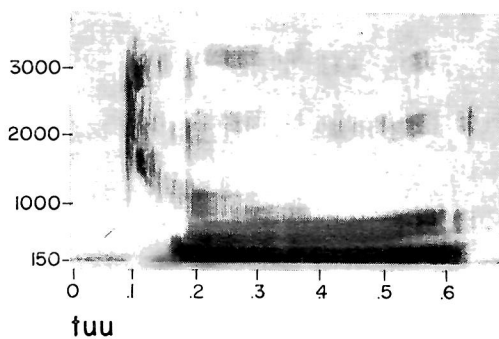
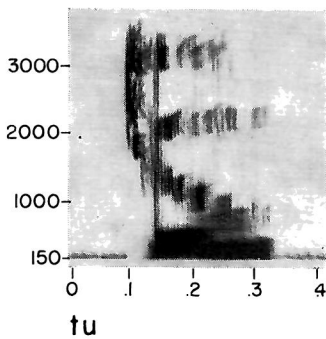


FIG. 10 TIME IN SECONDS

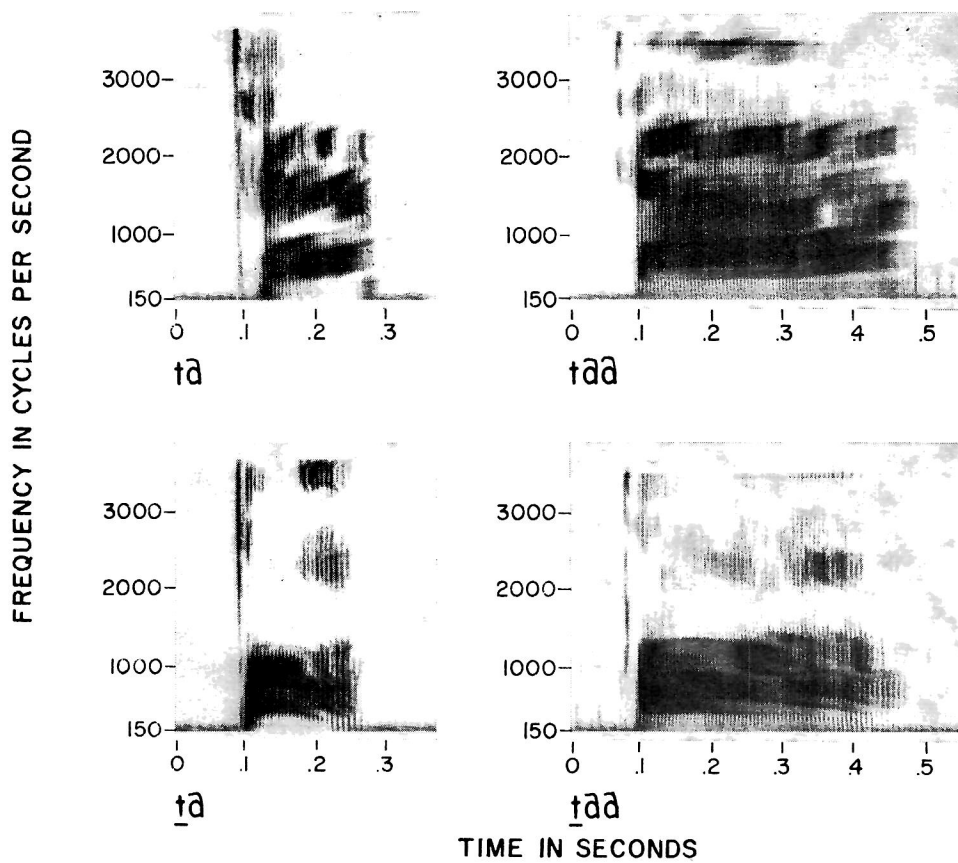


FIG. 11

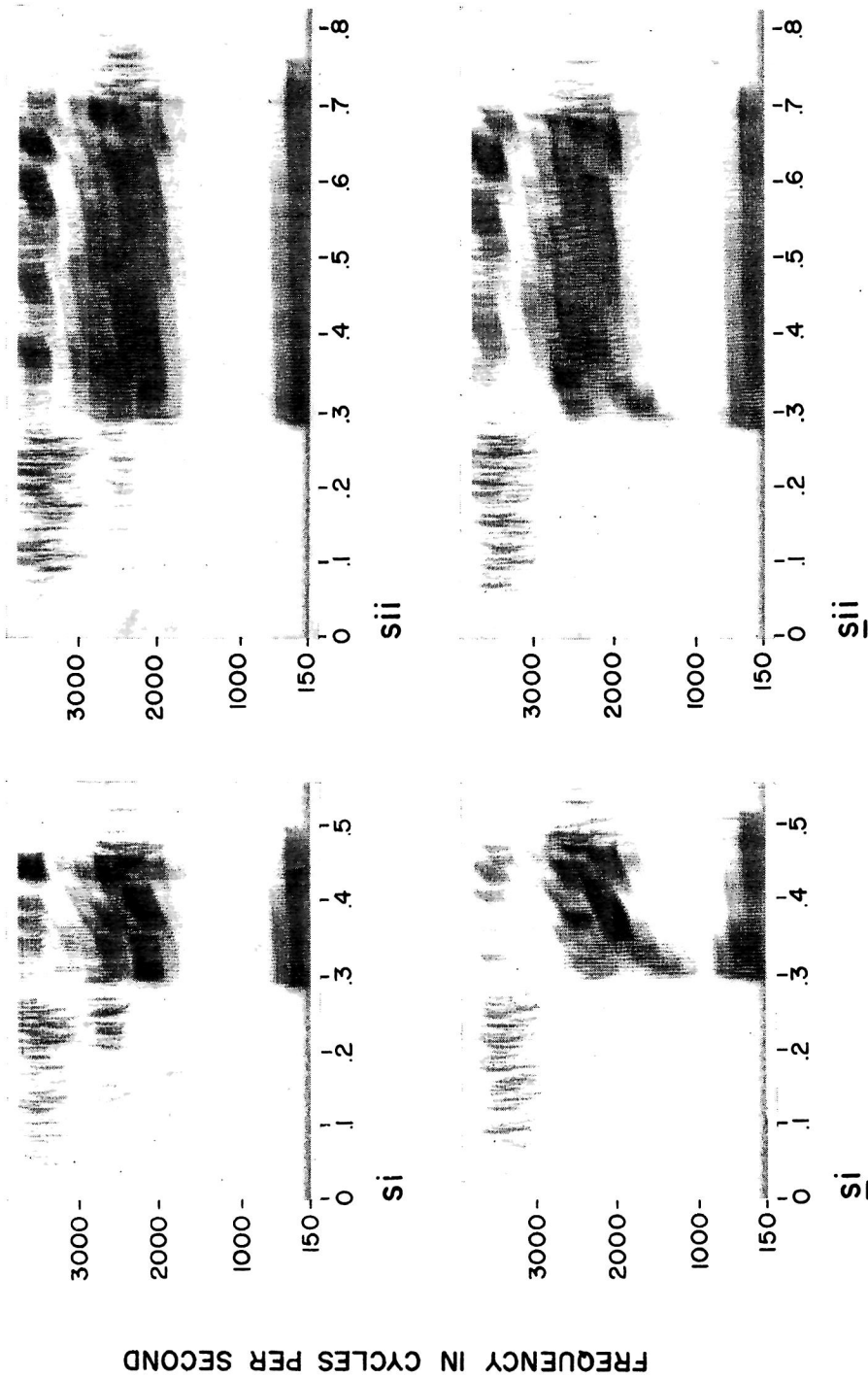


FIG. 12

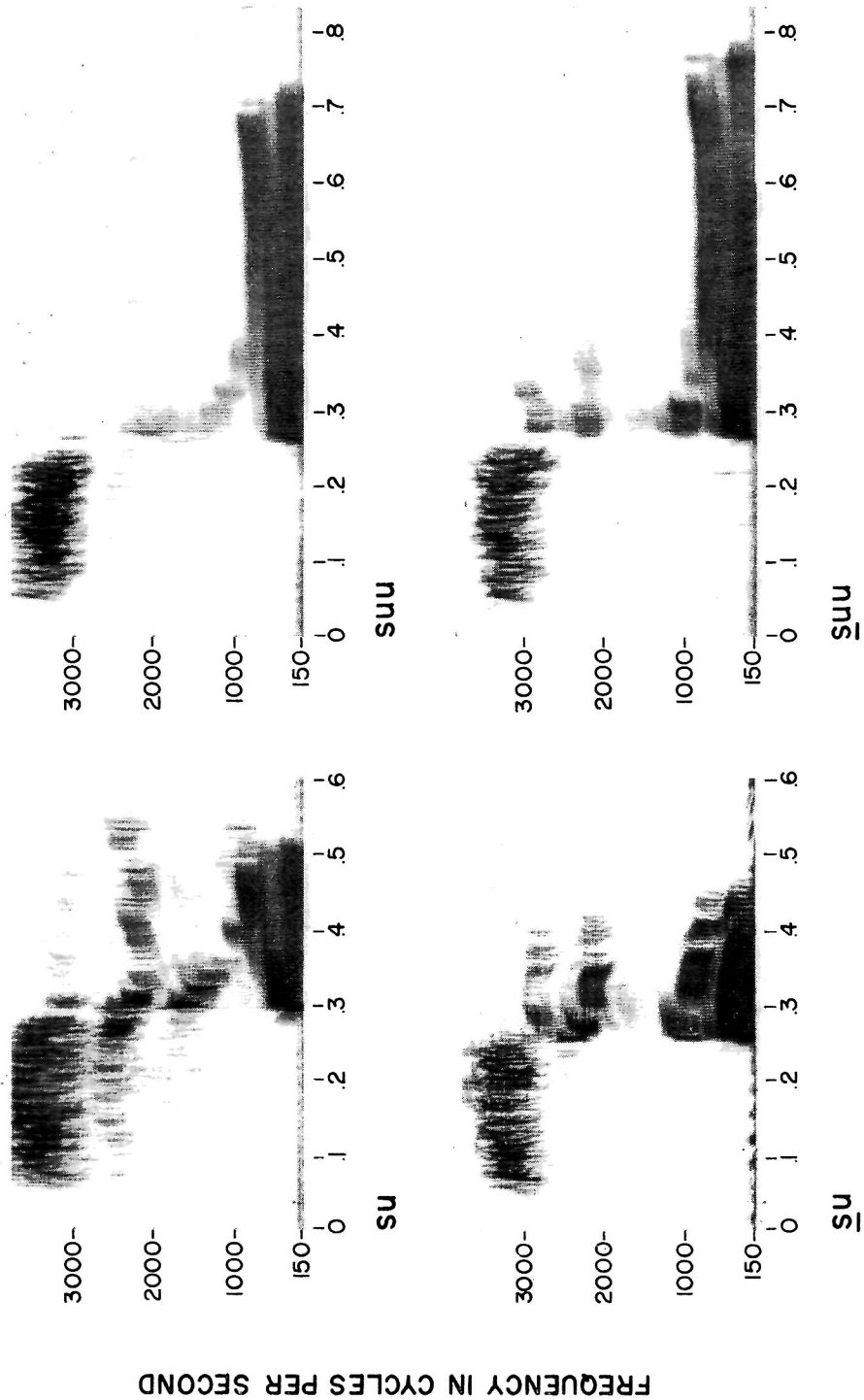


FIG. 13

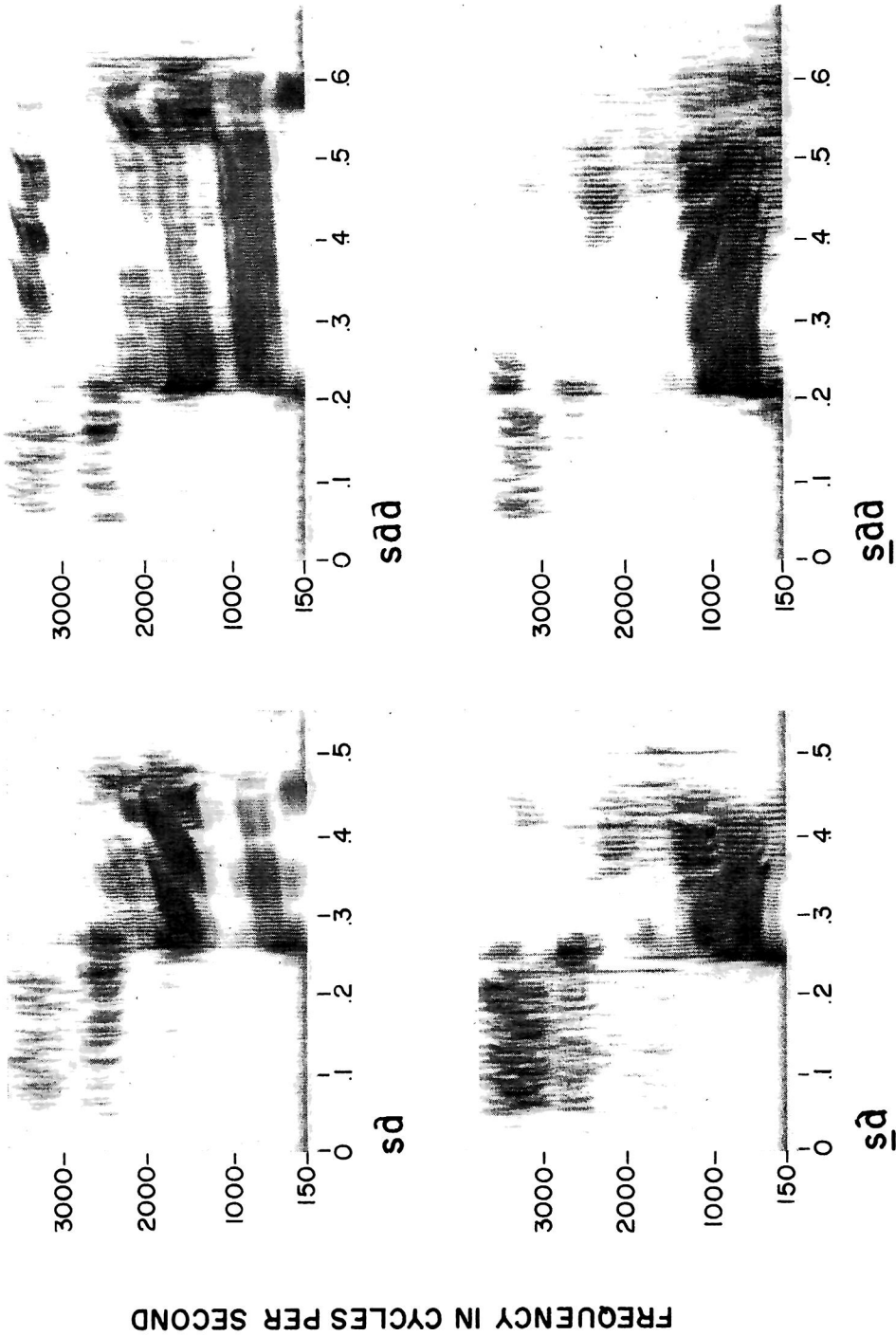
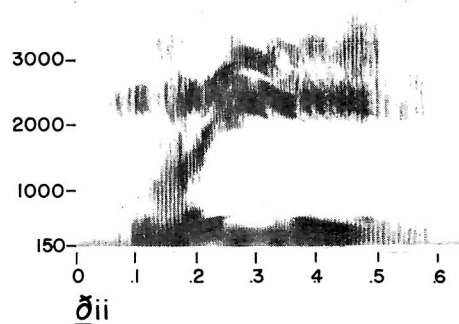
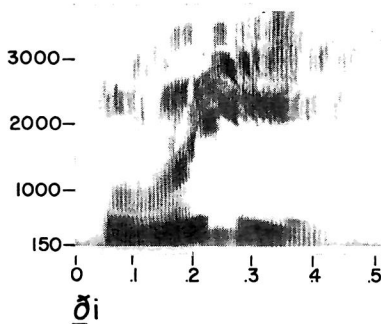
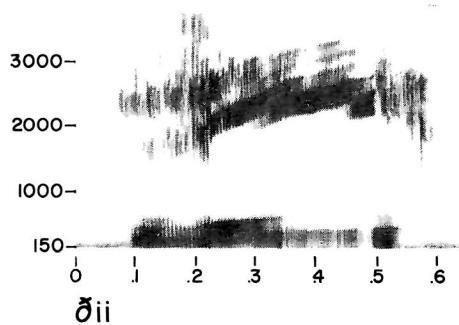
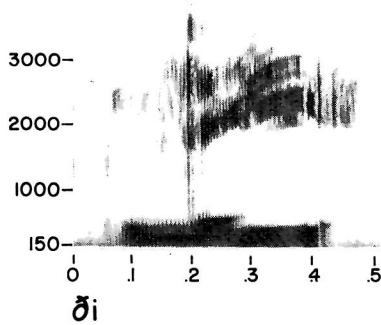


FIG. 14

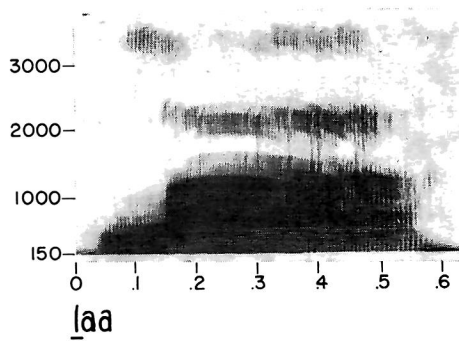
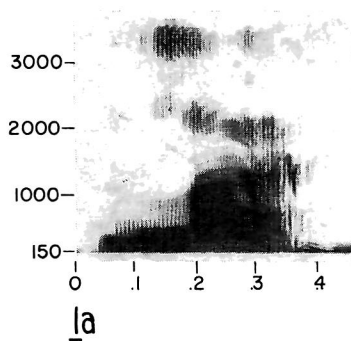
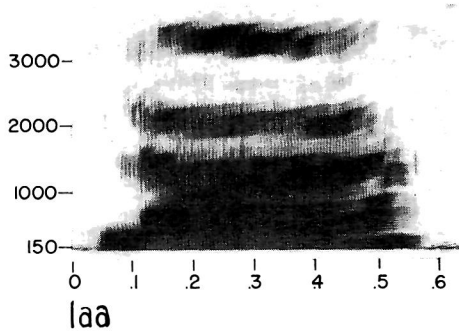
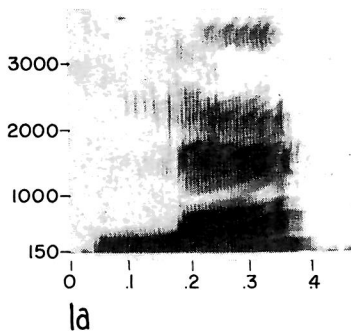
FREQUENCY IN CYCLES PER SECOND



TIME IN SECONDS

FIG. 15

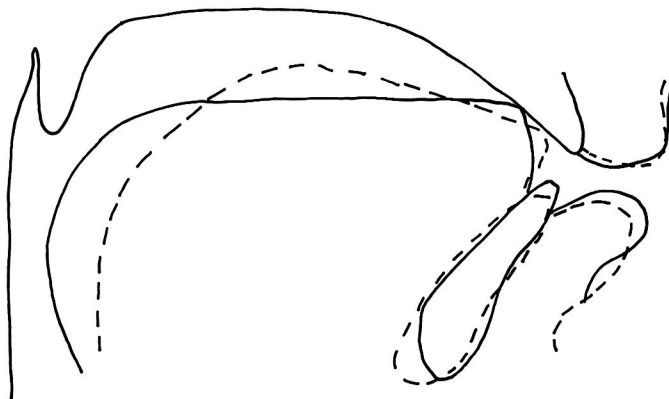
FREQUENCY IN CYCLES PER SECOND



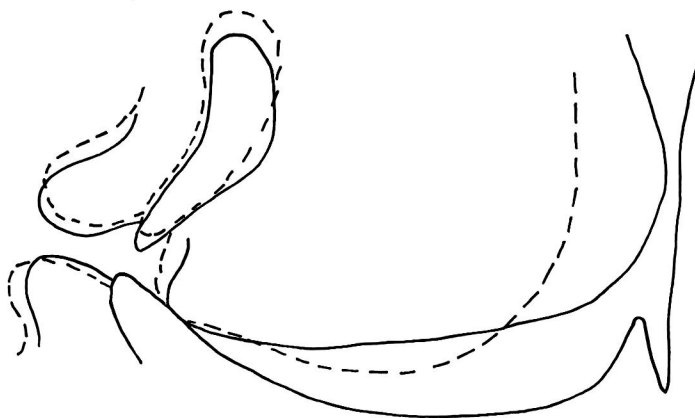
TIME IN SECONDS

FIG. 16

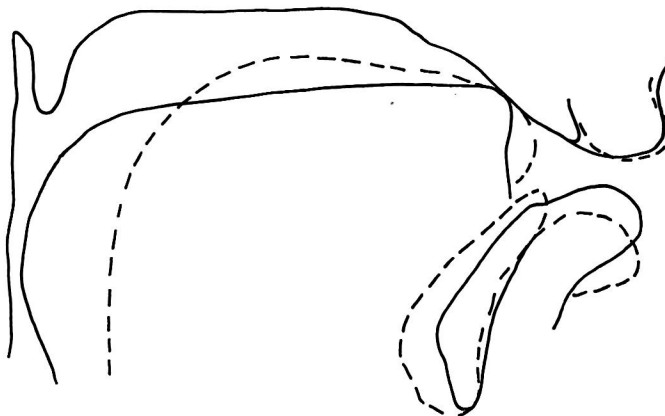




Tracing No. 11: / t / in / ti / -----  
/ t̤ / in / t̤i / ———



Tracing No. 12: / t / in / tu / -----  
/ t̤ / in / t̤u / ———



Tracing No. 13: / t / in / ta / -----  
                  / t̤ / in / ta / ———

## PHARYNGEALS AND GLOTTALS

The consonants in this chapter, /h/, /ħ/, /ʔ/ and /ε/, are distinguished from the rest of the consonants by having distinct vertical places of articulation. (See Chart II, page 29). A vertical place of articulation is defined as “a set of anatomical locations from the palate to the glottis, inclusive”.<sup>1</sup> In contrast, a horizontal place of articulation is “from the lips to the uvula, inclusive”.<sup>2</sup>

The pharyngeal and glottal consonants are much more difficult to investigate because of their points and manners of articulation which are in the pharyngeal and laryngeal areas and are not easily accessible.

Physiologically, these consonants were examined on X-ray films and the results were not as revealing as expected. Even though the films are extremely clear and cover the whole vocal tract, lips to glottis, it is very hard to see the movements of the pharyngeal muscles as only the posterior of the pharyngeal wall appears. It is equally as difficult to examine the interior of the larynx. This is because the films are two-dimensional. The tongue positions in producing the pharyngeals and glottals are quite clear but, unfortunately, this is not enough.<sup>3</sup>

The consonants have been divided into two groups — /h/ and /ħ/ and /ʔ/ and /ε/. The /h/ and /ħ/ have similar acoustical characteristics except for the formants of the neighboring vowels, especially F<sub>2</sub>, which is the distinguishing factor. This also applies for /ʔ/ and /ε/.

## 1. /h/ and /ħ/

/h/ The most common allophone is a voiceless oral fricative — duration 100-160 msec. When /h/ occurs intervocally, it is voiced. Usually /h/ appears as a noise. When next to /i/ and /ii/, the noise is concentrated around 2000-2700 cps and up, becoming lighter below 2000 cps

<sup>1</sup> Peterson and Shoup, *op. cit.*, p. 30.

<sup>2</sup> *Ibid.*, p. 29.

<sup>3</sup> Further examinations of these areas through means that visualize the vertical axis, showing the movements of the vocal muscles, will give a more complete picture.

and disappearing almost entirely below 1400 cps. When next to /u/ and /uu/, the concentration of noise is lower in frequency — usually starting around 1200 cps. There is rarely any noise appearing below 600 cps. However, when /h/ is next to /a/ and /aa/, the noise concentration appears around 1500-2000 cps and up with very little noise in the lower frequencies. There is hardly any energy below 1200 cps. It seems, from the above information, that the /h/ is unstable. Therefore, the vowels that neighbor it play an important role in determining the areas of the concentration of the noise.

The onsets of F<sub>2</sub> of /i/ and /ii/ with /h/ are lowered to about 2000 cps from 2200 cps. The onsets of /u/ and /uu/ with /h/ are raised to about 900-1000 cps from their usual steady-states of 750-800 cps. The F<sub>2</sub> of /a/ with /h/ is about 1500-1550 cps and with /aa/, 1350-1400 cps.

/h/ The most common allophone is a voiceless pharyngeal constricted fricative — duration 100-150 msec. Like /h/, it is voiced intervocalically. In producing the /h/ a constriction is formed by the dorsum of the tongue against the posterior wall of the pharynx where the movements of the pharyngeal muscles play an important role.<sup>4</sup> Primarily, this constriction differentiates the /h/ from the /h/. Acoustically, also like the /h/, it appears as a noise. However, with /h/ the noise is stronger and occasionally appears as a shadow of weak formant structures which are a continuation of the neighboring vowel formants. With /i/ and /ii/, the noise concentration is lower than with /h/ — about 1850-2600 cps and up. With /u/ and /uu/ it is around 1100 cps and up and with /a/ and /aa/, 1350-1900 cps.

The onsets of F<sub>2</sub> of /i/ and /ii/ with /h/ are lowered to 1750-1900 cps from 2150 cps; with /u/ and /uu/ the onsets of F<sub>2</sub> are slightly affected, going up to 900 cps; the F<sub>2</sub> of /a/ with /h/ is about 1400-1450 cps and with /aa/ 1300-1350 cps. See Figures 17 through 18, page 65 and Tracings 14 through 19, pages 72-74.

## 2.a. /ʔ/ – *Initially*

The /ʔ/ initially, on the spectrograms, appears to vary in appearance. In some cases, it occurs as a burst followed by a silence gap, duration 15-20 msec. Occasionally, the burst is followed by a weak noise.

In other cases, the /ʔ/ appears as a short onset glide initiating the vowel formants following it. As a matter of fact, it seems to be very unstable and does not set any definite pattern.

<sup>4</sup> It is possible, as suggested by Dr. Shoup, that a constriction is also formed by the false vocal cords. However, this phenomenon needs further physiological investigation.

With / i / and / ii / the concentration of the burst or onset glide appears along the areas of  $F_2 - F_3$  and very weakly along  $F_1$ . To be more precise, the concentration areas are shown at their best between 2000-2600 cps. The formants —  $F_1$ ,  $F_2$ , and  $F_3$  — are barely affected by / ʔ /. The onset and steady-state of  $F_1$  have frequencies about the same height. On a few occasions, there is a slight lowering of the transition of  $F_2$  from 2000 to 1900 cps.

The measurements of  $F_1$ ,  $F_2$ , and  $F_3$  of / i / and / ii / when next to / ʔ / range as follows:

$F_1$	280-300 cps.
$F_2$	2000-2150 cps.
$F_3$	2550-2700 cps.

With / u / and / uu /, there is no burst but a very weak glide initiating the vowel formants — especially along  $F_1 - F_2$ . The measurements of these vowels are:

$F_1$	280-300 cps
$F_2$	750-825 cps
$F_3$	2000-2100 cps

With / a / and / aa /, the majority of the time, the / ʔ / appears as a burst — duration 20-30 msec. The concentration of the burst — from 1500-1700 cps — is in the region of  $F_2$ . With / aa / the burst concentration is about 1350-1550 cps in the region of  $F_2$ . The reason it differs from / aa / is because / a / has a higher  $F_2$ . The formant measurements of / a / and / aa / are as follows:

$F_1$ / a /	575-650 cps
/ aa /	600-675 cps
$F_2$ / a /	1500-1600 cps
/ aa /	1300-1400 cps
$F_3$ / a /	2000-2200 cps
/ aa /	1950-2100 cps

#### b. / ʔ / — *Medially*

When / ʔ / occurs medially, other than intervocalic, it appears as a silence gap — duration 80-100 msec. This duration includes the burst which has a length of 15 msec.

The / ʔ / intervocalically does not appear as a gap but rather as a vowel-like glide which is shown on the spectrograms as a link connecting the formants of  $F_1$ ,  $F_2$ , and  $F_3$  of the vowels preceding and following it. The frequencies of the transitional region are weaker and, in a few cases, appear to be interrupted by a small gap or two along  $F_2$  and  $F_3$ .

The vowel measurements for the / ʔ / medially are similar to those of the / ʔ / initially.

c. /ʔ/ – *Finally*

The /ʔ/ in final position is in free variation — released or unreleased. When released, the release is indicated by a burst that appears as a vertical line which may or may not be followed by weak noise. This burst is preceded by a silence gap — duration 180-200 msec. The vowel measurements for the /ʔ/ in final position are similar also to the ones listed with the initial /ʔ/.

3.a. /ε/ – *Introduction*

The /ε/ is described as a voiced pharyngeal fricative in all previous works on Arabic, literary as well as dialectal. However, after a thorough acoustical analysis, the author has found that the most common allophone of /ε/ is actually a *voiceless stop* and *not* a voiced fricative.<sup>5</sup> This, of course, is not completely conclusive as there is much room for further research both on the acoustical and physiological levels.

b. /ε/ – *Initially*

Generally, on the spectrograms, the /ε/ appears as a burst — duration 40-50 msec — followed by a random noise. The burst appears first as a vertical line followed by noise, the amount of which varies from one example to another. This noise, most of the time, appears as a “voiced noise”.<sup>6</sup>

When /ε/ is followed by /i/ or /ii/, the burst is much higher — to 1650 cps — than when followed by other types of vowels and its noise intensity is somewhere between 1475-1550 cps.

The /ε/, in this position, affects the onsets of F<sub>1</sub>, F<sub>2</sub>, and to a certain extent F<sub>3</sub> of /i/ and /ii/. F<sub>1</sub>, which is usually between 275-300 cps, is raised to 400 cps and sometimes even higher. F<sub>2</sub>, which has frequencies of 2000-2200 cps as its usual steady-state, is lowered to 1500 cps and sometimes lower. This lowering transition is gradual for the duration which varies from 50-100 msec — the majority around 75 msec.

When /ε/ is followed by /u/ or /uu/, the burst goes up to 1200 cps — the intensity being around 950-1100 cps. The /ε/ also exerts influence on the onsets of F<sub>2</sub> of /u/ and /uu/ and raises them to 950 cps, sometimes slightly higher, from their usual steady-states of 750-800 cps.

When /ε/ is followed by /a/ or /aa/, the burst goes up to about 1400-1500 cps — the intensity being around 1275-1350 cps. The F<sub>2</sub> onset of /a/ is from 1300-1350 cps and the F<sub>2</sub> onset of /aa/ from 1250-1300 cps. This is because F<sub>2</sub> of /aa/,

<sup>5</sup> In reaching this conclusion, spectrograms were made, specified and measured for four different people — myself, and three other informants from different sections of Iraq.

<sup>6</sup> The term “voiced noise” is borrowed from D. H. Obrecht, *Effects of the Second Formant in the Perception of Velarization in Lebanese Arabic*, 1961, p. 30.

as a whole, is lower than  $F_2$  of / a /. In actuality, not only the onset of / a / is affected but the whole of  $F_2$ , 1300-1375 cps and also the  $F_2$  of / aa /, 1250-1325 cps.

c. /  $\varepsilon$  / – *Medially*

The detailed characteristics of the /  $\varepsilon$  / medially are determined by their environments and whether the /  $\varepsilon$  / is single or geminated.

(1.) *Geminated*

When the /  $\varepsilon$  / is geminated, it always is intervocalic and appears as a silence gap — duration 300-330 msec. This gap is preceded by some sort of a glide — duration 30-40 msec — of the preceding vowel in  $F_1$  and  $F_2$ . The glide appears as two horizontal humps followed by the gap which is followed by a burst — similar to that of the initial /  $\varepsilon$  /. However, the burst duration is sometimes longer than with the initial /  $\varepsilon$  / — from 50-70 msec — and its frequencies go up to 1450 cps. The  $F_2$  of the vowels following /  $\varepsilon\varepsilon$  / are also affected and the measurements are similar to the ones listed with the initial /  $\varepsilon$  /.

(2.) *Intervocalically*

The /  $\varepsilon$  / intervocalically is in free variation either appearing as a stop or as a glide continuation of the preceding and following vowel formants. However, these formants, with the voiced noise accompanying them most of the time, are not always regular. Oftentimes the space that the /  $\varepsilon$  / occupies appears as an irregular random striation of voiced noise with no clear tracing of formants — especially in the center of the position of the /  $\varepsilon$  /. The frequencies of  $F_1$  and  $F_2$  of the vowels are like the ones stated above for the initial /  $\varepsilon$  /. No tracing at all, of any frequency, is visible on the spectrograms above 2000 cps.

(3.) *Medially*

When the /  $\varepsilon$  / is preceded by a consonant it is not affected because it belongs to a different syllable and the conditioning hardly goes beyond the syllable boundary except with pharyngealized consonants.

When the /  $\varepsilon$  / is followed by a consonant, it appears as a silence gap — duration 80-100 msec — followed by a burst — duration 30-40 msec.

When the /  $\varepsilon$  / ends a syllable, it is a stop. The frequencies of the vowels are as with the initial /  $\varepsilon$  /.

d. /  $\varepsilon$  / – *Finally*

When the /  $\varepsilon$  / occurs finally, it is either released or unreleased. When released it is usually aspirated and appears on the spectrograms as a silence gap — duration

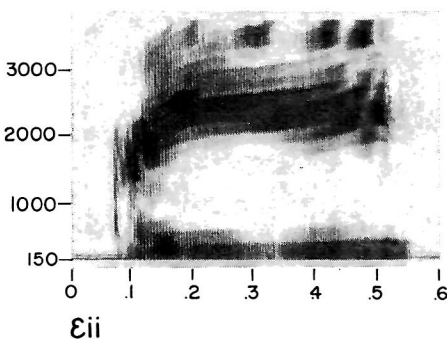
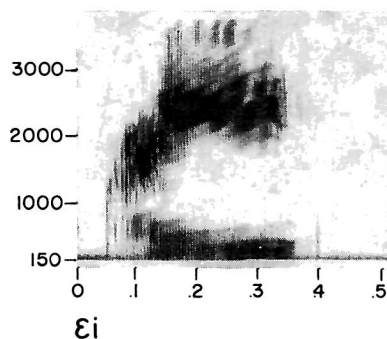
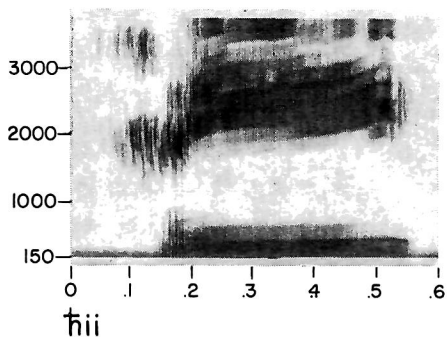
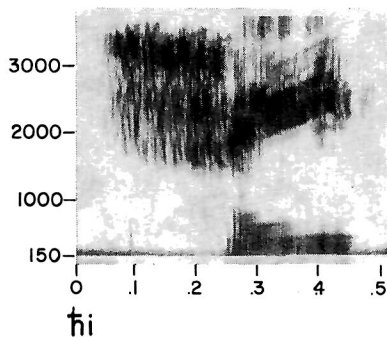
170-200 msec — and it is preceded by a glide in  $F_1$  and  $F_2$  of the preceding sound, usually a vowel. The influence appears, on the preceding vowel, as an off-glide continuation of the preceding vowel along  $F_1$  and  $F_2$ , with the end of  $F_2$  appearing as a hump pointing downwards. This off-glide sometimes appears not only in  $F_1$  and  $F_2$  but also as a random voiced noise at the end of the frequencies of the vowel — from the baseline up to 1300-1400 cps. The duration of the glide is between 40-60 msec.

The gap, mentioned above, ends in a breath release which usually appears as a noise. However, it sometimes appears as a weak spike — the frequencies of which are somewhere around 1000 cps with a duration of 40-75 msec.

When the / $\epsilon$ / occurs finally and is unreleased there is no way of measuring its duration because nothing appears on the spectrograms. See Figures 17 through 24, pages 65-71 and Tracings 14 through 19, pages 72-74.



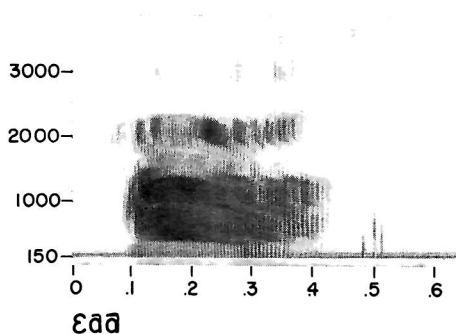
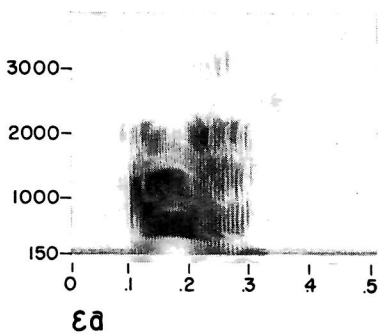
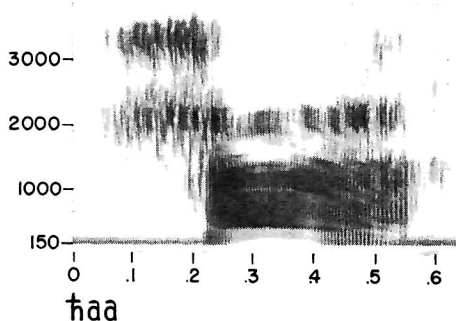
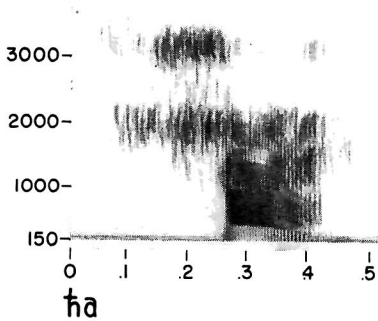
FREQUENCY IN CYCLES PER SECOND



TIME IN SECONDS

FIG. 17

FREQUENCY IN CYCLES PER SECOND



TIME IN SECONDS

FIG. 18

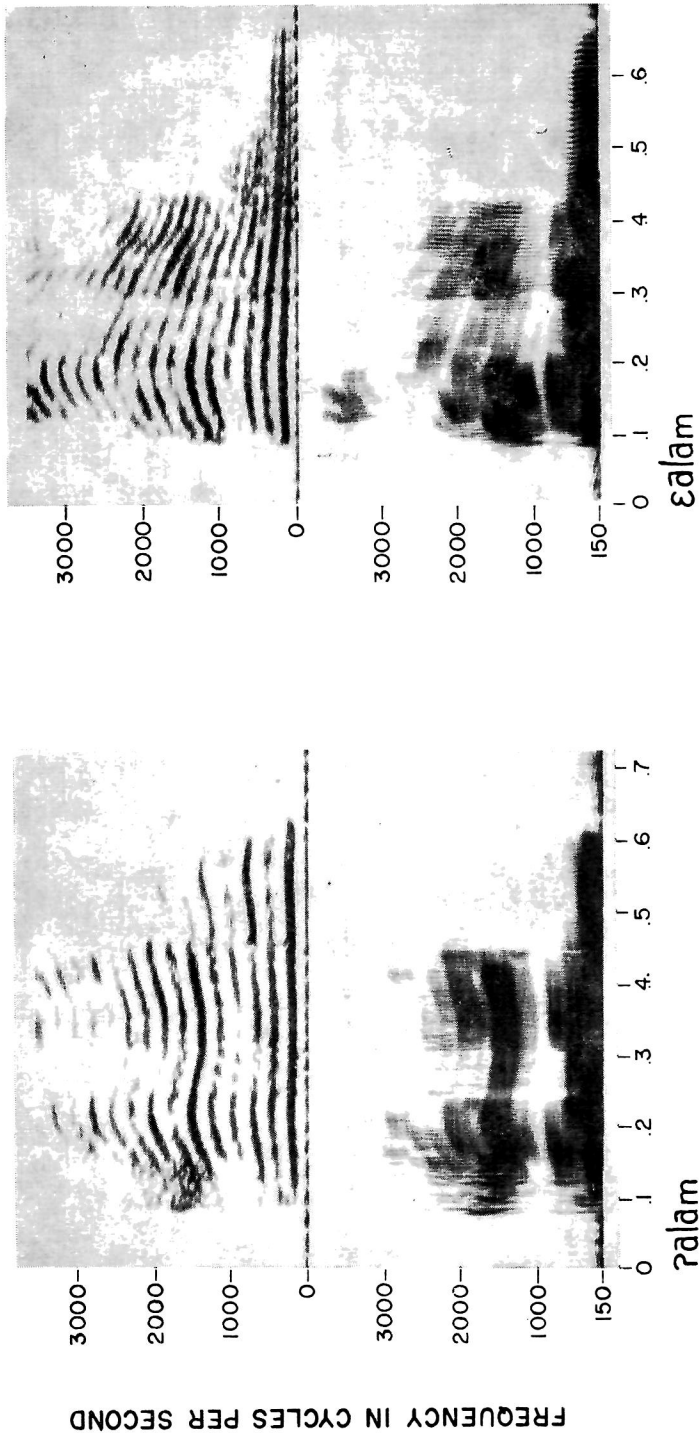


FIG. 19

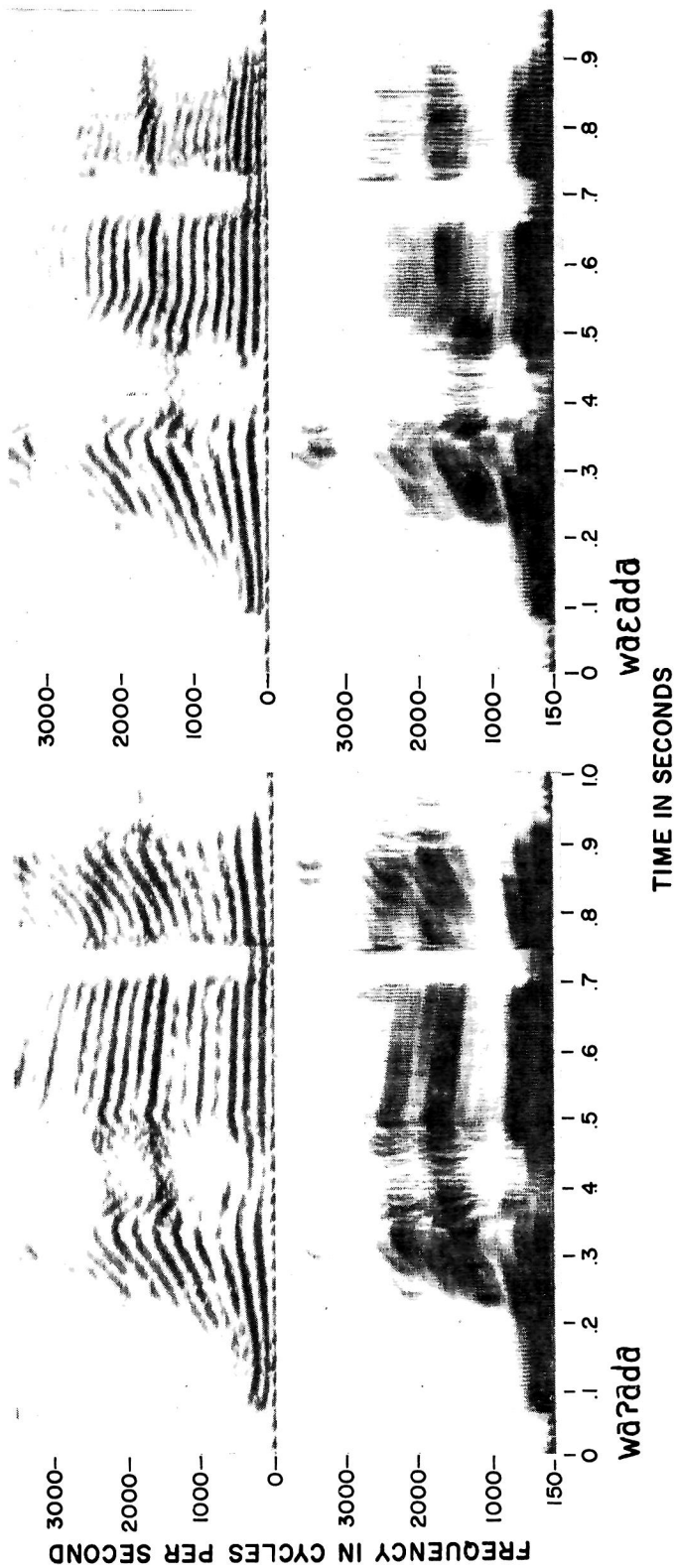


FIG. 20

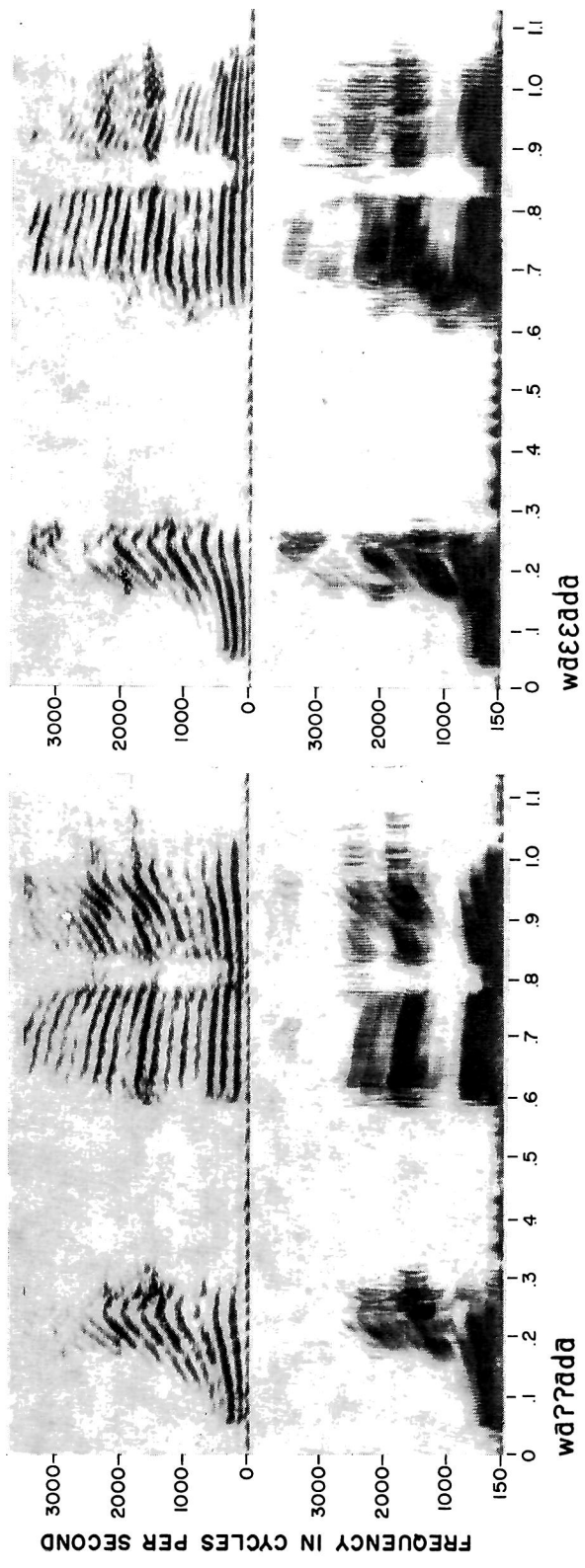


FIG. 21

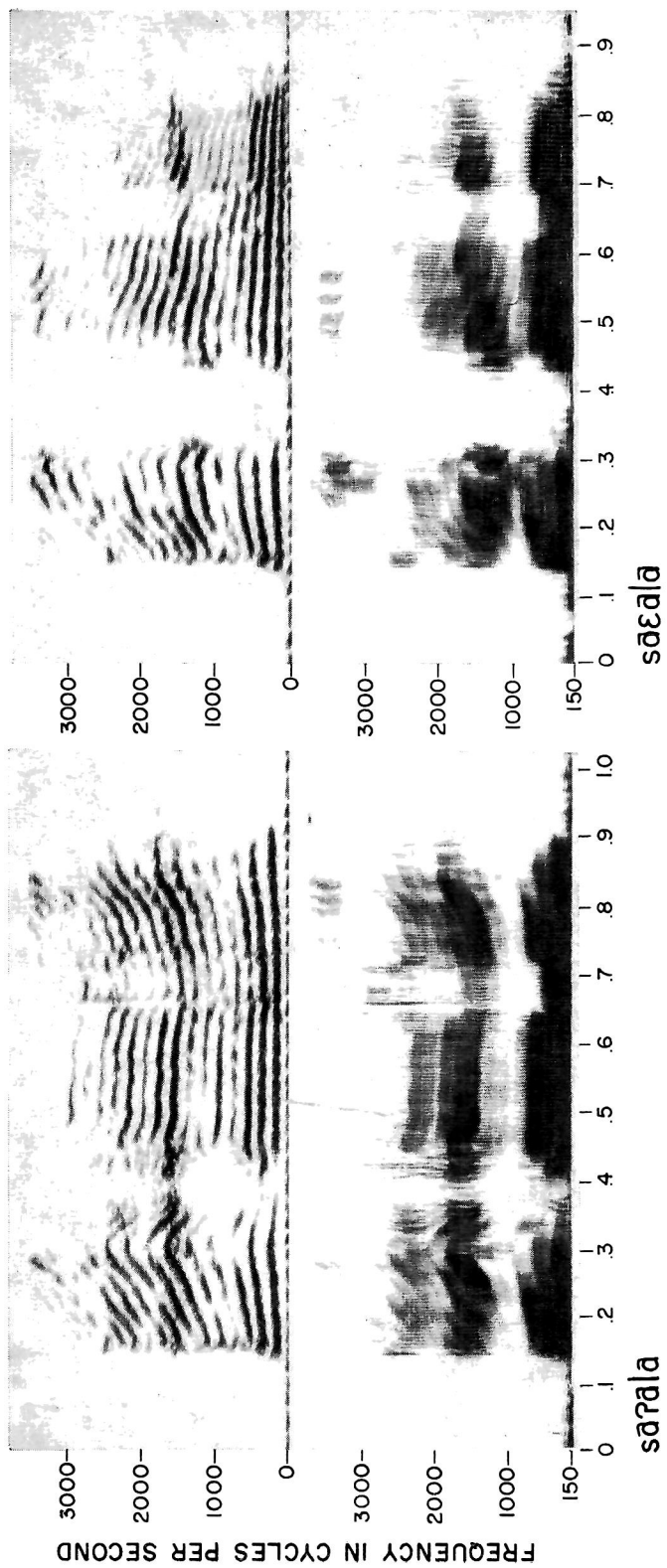


FIG. 22

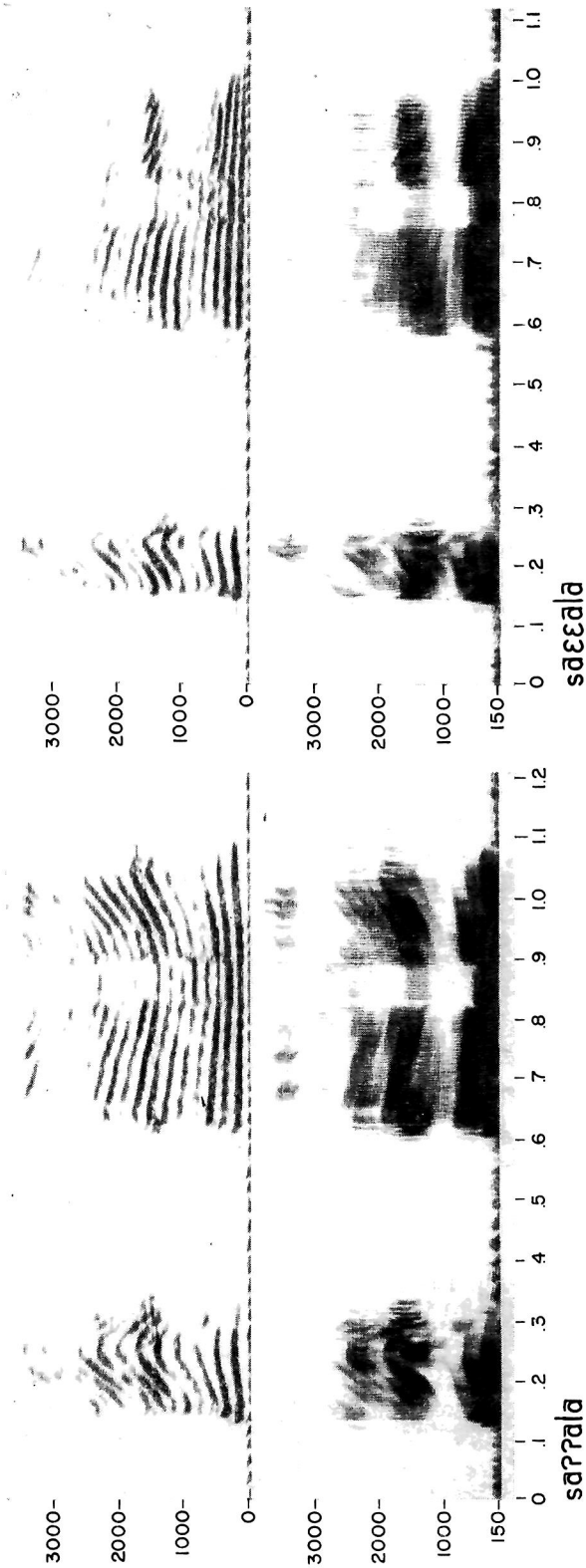


FIG. 23

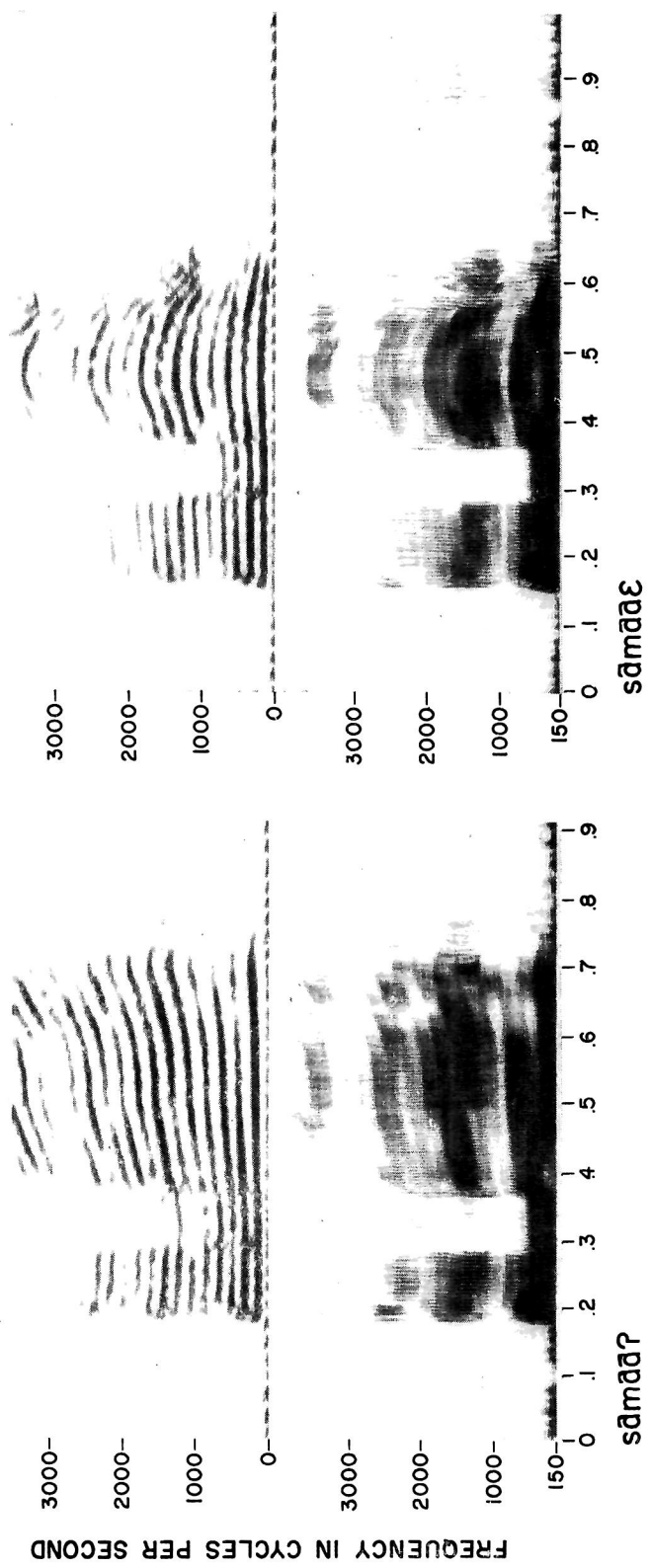
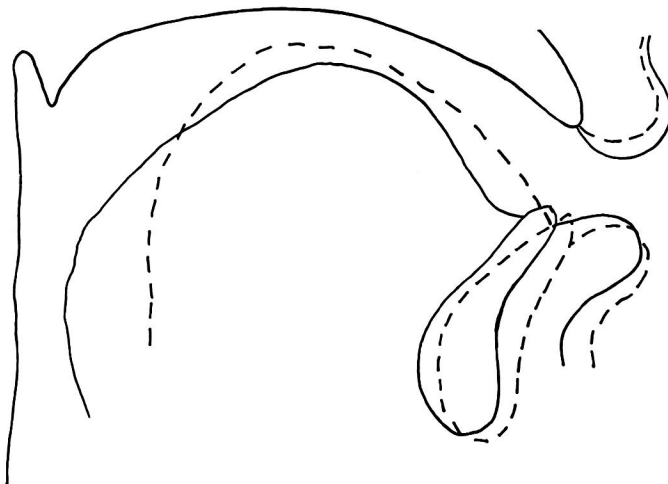
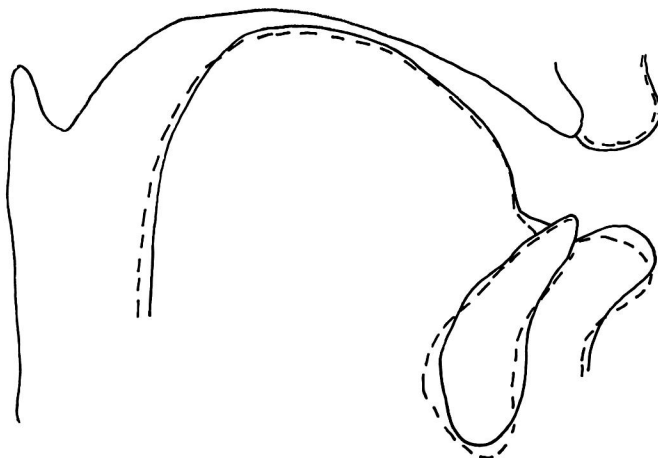


FIG. 24

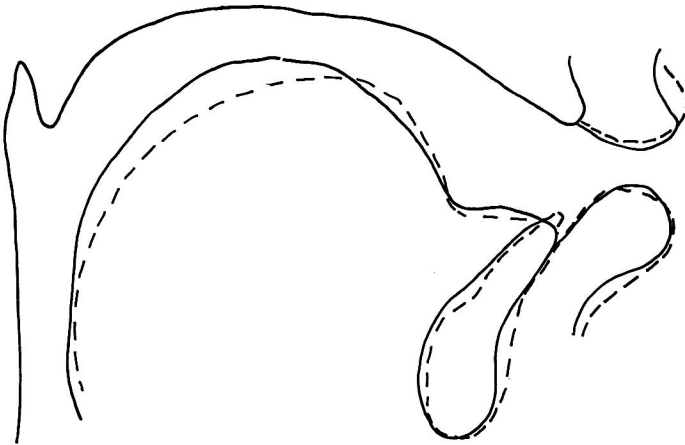


Tracing No. 14: /h/ in /h/ -----  
/ε/ in /εi/ ——

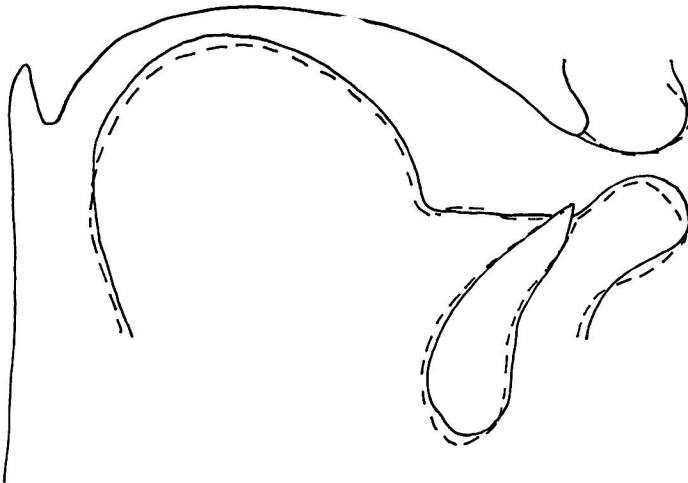


Tracing No. 15: /i/ in /hi/ -----  
/i/ in /ei/ ——

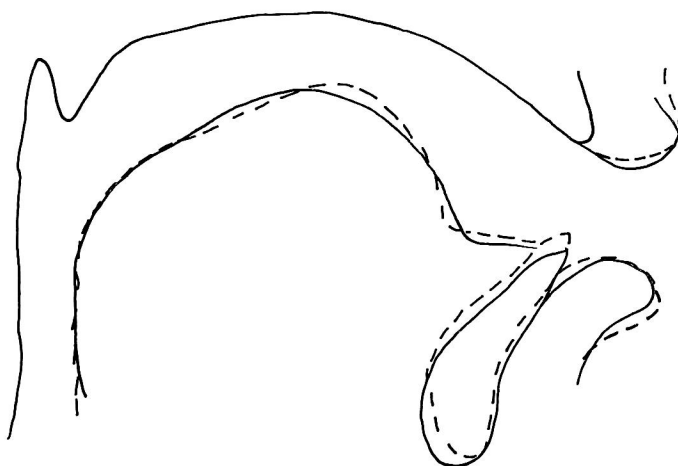




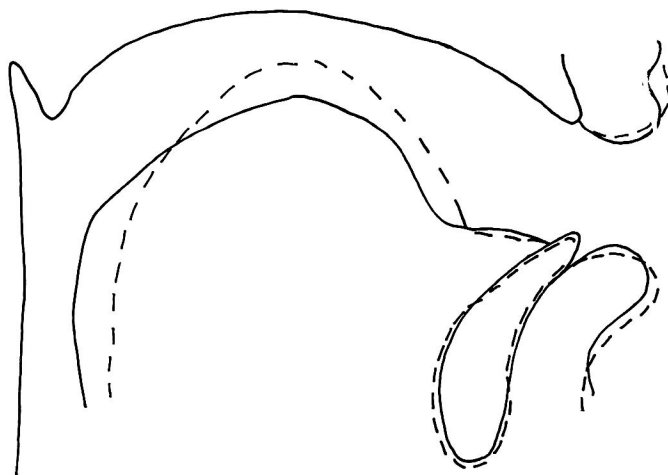
Tracing No. 16: / h / in / hu / -----  
/ ε / in / εu / ———



Tracing No. 17: / u / in / hu / -----  
/ u / in / εu / ———



Tracing No. 18: / h / in / ha / -----  
/ ε / in / εα / ———



Tracing No. 19: / a / in / ha / -----  
/ a / in / εα / ———

## VI

### DURATION, GEMINATION AND CONSONANT CLUSTERS

#### A. DURATION

The duration of a sound is the actual time it takes to produce it. The amount of time can be measured and specified, but the significant temporal variable is not absolute but rather is relative. The relative duration of a certain phone depends on the environment, how fast an individual speaks, and other factors.

Length is significant in the language and the difference in the length of a vowel or consonant makes a difference in meaning:

/ sin /	‘tooth’
/ siin /	‘the letter(s)’

#### B. VOWEL LENGTH

The three short vowels operate phonemically and they may be prolonged to their long counterparts. The difference between short and long vowels is approximately double or more. The high front and back vowels differ in quantity whereas the low central vowels differ both in quantity and quality.

The relative duration of the short vowels is from 100-150 msec. With the long vowels it is from 225-350 msec. These durations do not apply for vowels when in isolation. (See Chapter II). Since vowels do not occur initially, vowel length can only operate medially and finally. It is more common medially.

#### C. CONSONANT LENGTH

The relative duration of the consonants depends upon whether they occur initially, medially or finally. It also depends on whether they are aspirated or unaspirated, voiced or voiceless, and single or geminated.

### 1. *Nasals*

The durations of the nasals are easy to measure because they possess a voice bar along the baseline from which the measurements may be determined. On the whole, / n / seems to be longer than / m /. Initially, the durations for the nasals are from 70-100 msec; medially, 70-90 msec; medially geminated, 275-330 msec; finally, 110-140 msec; and finally geminated, 280-320 msec.

### 2. *Stops*

#### a. *Voiced*

The average durations of voiced stops in initial and medial positions were determined by measuring the voice bar that appears along the baseline of the spectrograms. The durations: initially, 130-150 msec; medially, 50-60 msec and medially geminated, 300-350 msec.

For final voiced stops, in free variation — released or unreleased, the voice bar continues from 60-70 msec. When released, there is a silence gap ending in a release — duration, including voice bar — about 180-200 msec. When the final voiced stops are geminated, the voice bar appears longer — about 100 msec. and when released, the duration including the voice bar is about 250-300 msec. See Figure 25, page 82.

#### b. *Voiceless*

Initial voiceless stops appear as silence gaps followed by bursts and can only be measured by these bursts. There is no way to tell where they actually start so the measurements given are those of the bursts. When the stops are aspirated — durations 35-60 msec — the lengths of the bursts are always longer than with unaspirated stops whose lengths are from 20-40 msec.

Voiceless single stops in medial position are generally longer than the voiced ones — duration 110-130 msec for the aspirated ones and 100-120 msec for the unaspirated ones. When they are medial and geminated there does not seem to be much difference between aspirated and unaspirated voiceless stops. The durations are from 300-350 msec.

In final position, voiceless stops are in free variation — either released or unreleased. The clue for measuring their duration is the vertical line of the release. When unreleased they appear as a plain gap and cannot be measured because there is no indication of their ending. When released, the durations are about 200 msec. When released and geminated, the durations range from 325-350 msec. Geminated / ʔ / does not occur in this position. See Figures 26 and 27, pages 83 and 84.

### 3. *Trill*

The trill, / r /, is very difficult to measure accurately because it has formants that glide into the preceding and following vowel formants. The approximate durations

are: initially, 40-60 msec; medially, 40-50 msec; and finally, 40-60 msec. No information occurred in the data assembled for geminated /r/, medial or final.

#### 4. *Fricatives*

The fricatives vary more in their duration measurements than any of the other consonant groups. This is because they are flexible in their pronunciations — they can be lengthened as long as the air flow allows. Actually, all of the other phones, except the stops, share this phenomenon with the fricatives. However, there is more variance with the fricatives. Therefore, the durations given for the fricatives are compiled from the voice bar and the noise for the voiced ones and from the noise spectrum for the voiceless. The measurements are: initially, 100-180 msec; medially, 110-200 msec; medially geminated, 280-375 msec; finally, 90-200 msec; and finally geminated, 250-350 msec. See Figure 28 page 85.

#### 5. *Sonorants*

The /w/ and /y/ seem to share similar measurements: initially and medially about 100-120 msec and finally, 100-140 msec. No data were available for measuring /w/ and /y/, geminated, in medial and final positions.

The measurements of the /l/ and /ɭ/ are: initially, 100-120 msec; medially, 60-75 msec; medially geminated, 300-375 msec and finally, 120-130 msec (/ɭ/ occurs medially only).

#### 6. *Gemination*

##### a. *Geminated Consonants*

“Gemination involves prolongation of the continuants and a longer closure of stops”.<sup>1</sup> Geminated (long) consonants are regarded as identical clusters. Where the syllable boundary is concerned, the first member of the identical and non-identical cluster occurs as a coda of the preceding syllable, and the second member always occurs as an onset of the following syllable.

/ʔabbað /	CVC-CVC	‘cause to eternalize’
/mattaṇ /	CVC-CVC	‘cause to be strong’

Every consonant cluster involves a close transition which means that the first member of the cluster — always occurring as a coda — is not released until the second member — always occurring as an onset — is uttered.

The geminated consonant clusters contrast with their corresponding single consonants.

/qatala /	‘he killed’
/qattala /	‘he slaughtered’

<sup>1</sup> Haim Blanc, *Studies in North Palestinian Arabic* (Jerusalem, 1952), p. 73.

/ kasara /	'he broke'
/ kassara /	'he destroyed'

#### b. *Long Vowels*

The long vowels are considered as monophthongs and not as diphthongs. In comparison to consonant clusters, (described in the following section) these sequences, which are identified as monophthongs, have the same significance where the syllable boundary is concerned. As indicated in describing the consonant clusters of both identical and non-identical members, the syllable boundary always divides the cluster. Nevertheless, the long vowels always stay within the syllable frame which means the syllable cut never divides them. The examples given below illustrate this point.

/ kaatib /	CVV-CVC	'writer'
/ maɛlumaat /	CVC-CV-CVVC	'information'

### 7. *Consonant Clusters*

Consonant clusters consist of two elements only.<sup>2</sup> They never occur initially but they do occur both medially and finally.

The possibilities of medial and final clusters are listed on the following charts. The consonants in horizontal position represent the first member of each cluster and the ones in vertical position represent the second member. The possibility of a cluster occurring is indicated on the charts by a plus (+) sign. The blank spaces suggest that either a cluster does not occur or that no example can be found. A quick glance at the two charts shows that the medial clusters are more abundant than the final clusters.

In examining the charts, it is observed that two consonant groups may be distinguished on the basis of their frequency of occurrence with each other. These two groups may be referred to as front consonants and back consonants. The back group includes the velar, uvular, pharyngeal, and laryngeal consonants. The front group includes the remaining consonants and, as a whole, this group forms clusters freely with the back group.

The consonants / b /, / f /, / m /, / n /, / r /, / l /, / ʒ /, / w / and / y /, which all have front points of articulation, need special attention.

The two sonorants / w / and / y / as well as the affricate / ʒ / form clusters with all of the consonants both medially and finally. The bilabial / b / and the labiodental / f / occur freely with both back and front consonants, medially and finally, with the exception of / bf /, / bm /, / fb /, / fm / and / fh /. The / fh / occurs medially and may occur finally but the author has not been successful in finding an example

<sup>2</sup> Across word boundary a three element cluster may be formed. However, the three consonant sequence is always broken by the insertion of one of the three short vowels. The vowel used the most is the / i / and the one used the least is the / a /.

for it. Similar to /b/ and /f/, the /m/ occurs with all consonants except /f/. The consonants /n/, /r/ and /l/ occur with all consonants, medially and finally, except for the following combinations: /nr/, /nl/, /rl/, /ln/, and /lr/.

The front dental stops occur freely with the fricatives. However, the front stops do not form clusters with each other and neither do the front fricatives. The /θ/, /ð/ and /ð̣/ are of low frequency occurrence as compared to the rest of the consonants. Therefore, there are limitations on their forming of clusters especially with the front fricatives and, to a certain extent, stops.

Of the back consonants, /k/ and /q/ do not occur with each other and neither do /x/ and /ɣ/. Also, the /ħ/, /ε/ and /h/ do not occur freely with each other.

As explained in Chapter IV, page 46, the /ḍ/ does not occur in the author's speech. It is included on the charts for completion.<sup>3</sup>

<sup>3</sup> The author acknowledges the assistance of Mr. and Mrs. E. M. Sharqāwi of the U.A.R. for their help in compiling the consonant clusters, especially for their work on the /ḍ/.

### *Possibilities of Medial Consonant Clusters*

[illegible]



### Possibilities of Final Consonant Clusters

[illegible]

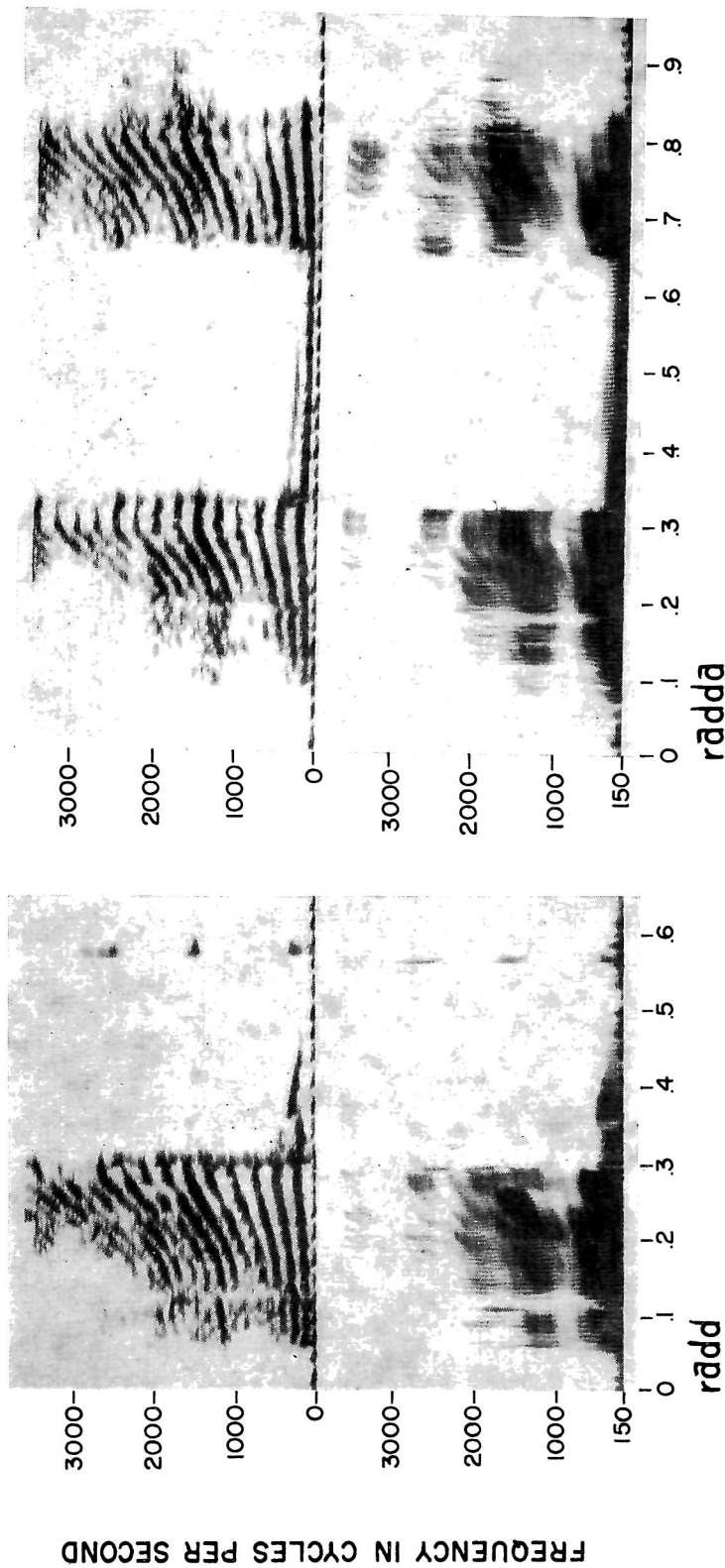


FIG. 25

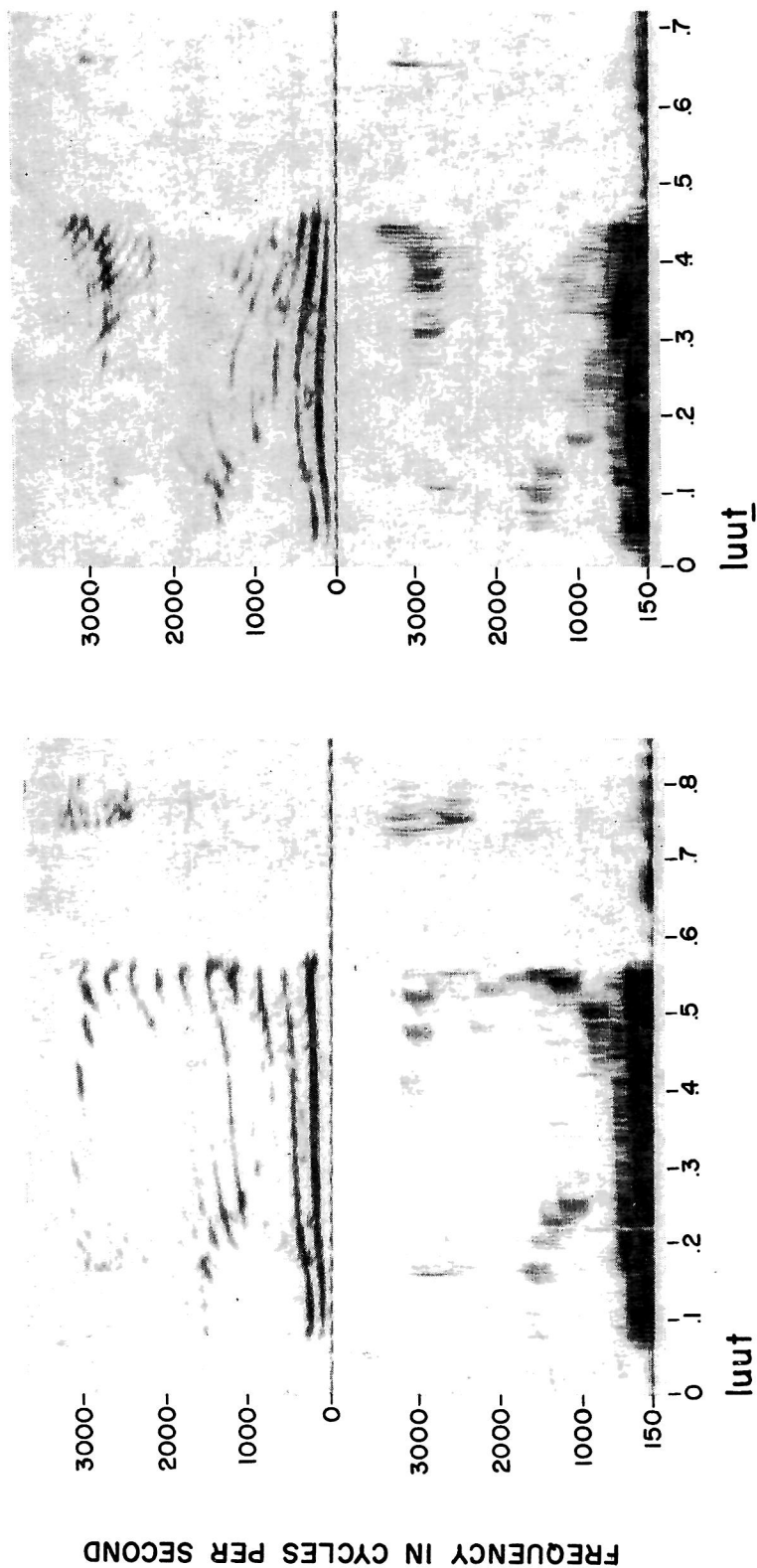


FIG. 26

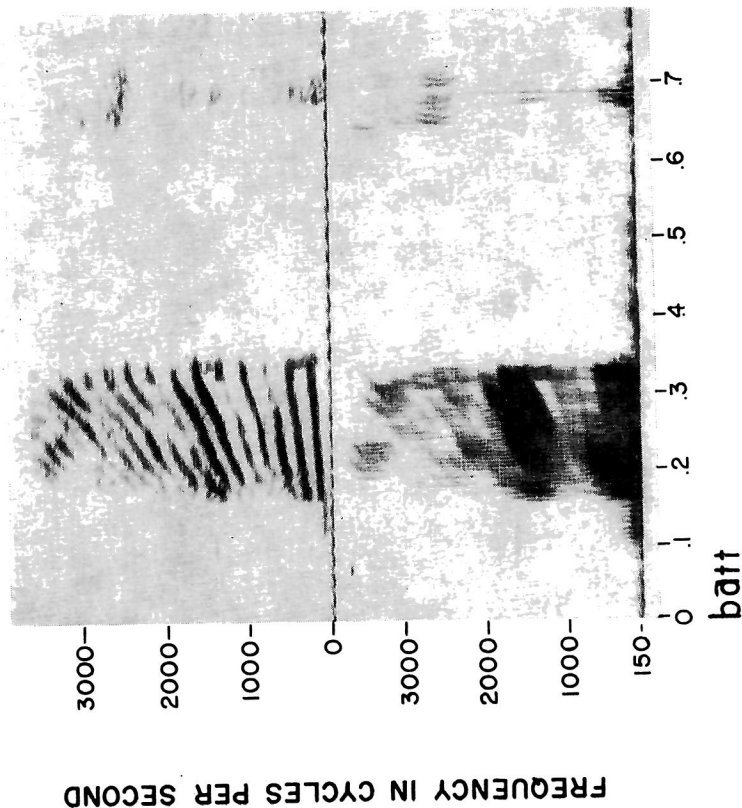
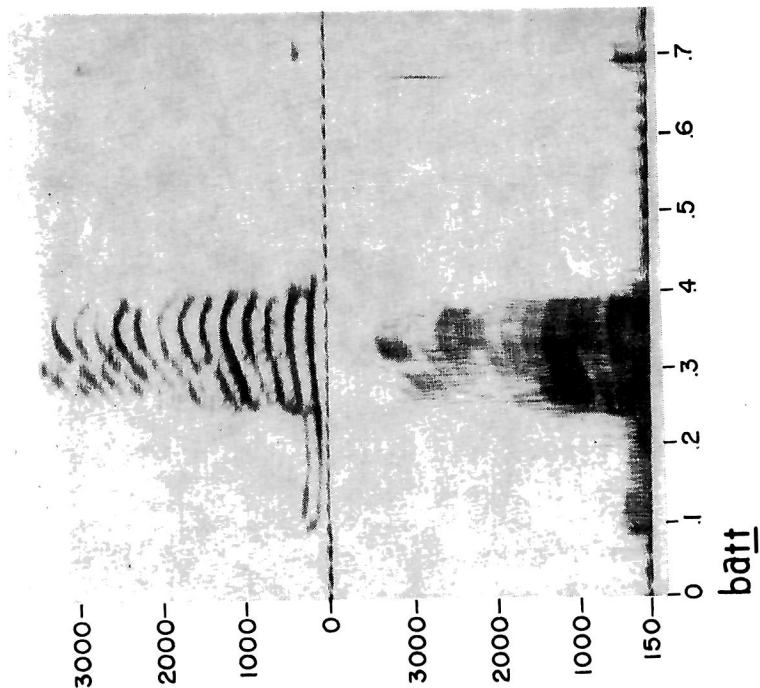


FIG. 27

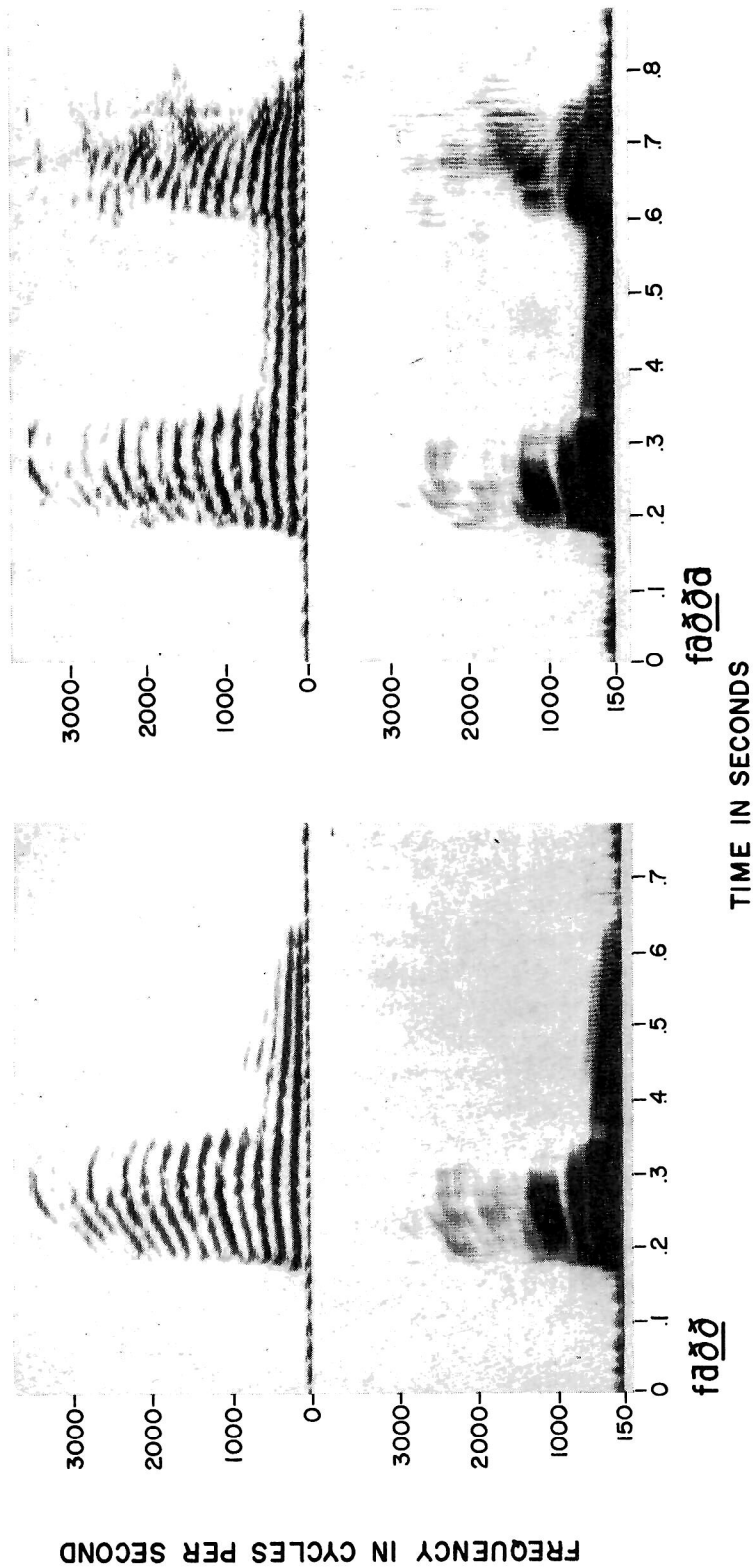


FIG. 28

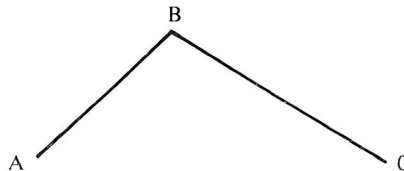
## VII

### SYLLABLE AND STRESS

The syllable in Arabic, as analyzed here, is based on the contrastive components that are contained in its structure. The successive contrastive elements within a syllable boundary are made up of the segmental phonemes of the language. Each syllable has a main part that stands out and has prominence. This part is referred to here as the 'nucleus' of the syllable. The remaining components are referred to as 'marginal factors'. Acoustically, the nucleus is represented by formant structures and it has more intensity than the marginals.

The segmental phonemes of Arabic are conveniently divided into syllabic and non-syllabic entities. The three short vowels and their long counterparts always form the syllable nucleus. All consonants, including the two sonorants, /y/ and /w/, always represent the marginal phonemes in the syllable structure. Inasmuch as there is a clearcut between the segmental phonemes — some occur as nucleus and others as marginal — there is no need for marking syllabicity which may be regarded as a non-distinctive characteristic of the vowels.<sup>1</sup> In accordance with the clear-cut division of vowels and consonants, the number of syllables in an utterance will be identical to the number of vowels therein.

The marginal phonemes may be represented by either the initiation or the termination of the syllable. The initiation is always a single consonant whereas the termination may be one of three elements: single consonant, two consonants, or zero consonant. On this basis the syllable structure can be represented as on the following diagram:



<sup>1</sup> Einar Haugen, "The Syllable in Linguistic Description", *For Roman Jakobson* (The Hague, Mouton and Co., 1956), pp. 213-221.

Point B always represents the nucleus of the syllable and points A and C represent the initiation and termination, respectively. The narrow band spectrogram displays of the harmonic movements illustrate the diagram — especially with a high pitched, stressed syllable.<sup>2</sup>

The A-B line symbolizes an increasing tension which appears on the spectrograms as shorter and much stronger than the B-C line which represents decreasing tension.

With weaker, unstressed syllables, the syllable nucleus does not necessarily rise or stand out.

#### A. SYLLABLE PATTERNS

There are five syllable patterns. In their representation C stands for all consonants, V for short vowels, and VV for long vowels. The VV are always considered as monophthongs. The five patterns are as follows:

- |          |          |                         |
|----------|----------|-------------------------|
| (1) CV   | / bi /   | ‘in’                    |
| (2) CVC  | / sin /  | ‘tooth’                 |
| (3) CVV  | / maa /  | negative particle ‘not’ |
| (4) CVVC | / baab / | ‘door’                  |
| (5) CVCC | / nahr / | ‘river’                 |

The first four patterns occur initially, medially and finally. The most common of these is CV and the least common CVVC.

The fifth pattern, CVCC, occurs only finally or in isolation.

Syllable may also be classified as: (1) short or long; CV is short and the remaining four long and (2) as closed or open. A closed syllable ends with a consonant and includes syllable patterns CVC, CVVC, and CVCC. An open syllable ends with a vowel and includes patterns CV and CVV.

#### B. STRESS

The syllables of an utterance are not produced with the same degree of loudness. In examining the sequences of syllables on the lexical item level, it has been found that three degrees are distinguishable for the purpose of the treatment of stress. The term ‘stress’ as used here stands for the amount of power that is distributed over the syllables of each utterance. On the lexical level, stress is predictable and therefore is not phonemic. The three levels that have been distinguished are: primary [ ' ], secondary [ ` ], and weak — unmarked.

<sup>2</sup> Bertil Malmberg, *Phonetics* (New York, Dover Publications, Inc., 1963), p. 68. Here the same diagram is used to represent the syllable in physiological terms. It seems to be in agreement with the acoustical representation given above.

Potentially, every word has an "inherently-stressable syllable".<sup>3</sup> This syllable receives the primary stress. Its location and distribution is affected by the number and types of syllables contained in the word-syllable sequences. A monosyllabic word, in isolation, receives the primary stress. Disyllabic and polysyllabic words receive secondary and weak stresses in addition to the primary stress.<sup>4</sup>

The rules that govern the lexical item stress are as follows:

- (1) When a word is made up of a string of the CV type syllables, the first syllable receives the primary stress and the remaining syllables receive weak stresses.

kátaba	CV̂-CV-CV	'he wrote'
dárasa	CV̂-CV-CV	'he studied'

- (2) When a word contains only one long syllable, the long syllable receives the primary stress and the rest of the syllables go unmarked receiving weak stresses.

káatib	CV̂V-CVC	'writer'
muεállimahu	CV-CV̂C-CV-CV-CV	'his teacher'

- (3) When a word contains two long syllables or more, the long syllable nearest to the end of the word (the very last syllable does not count) receives the primary stress and, in most cases, the one closest to the beginning receives the secondary stress.

raʔiisuhúnna	CV-CV̂V-CV-CV̂C-CV	'their chief' (fem. pl.)
mustàwdaεáatuhum	CVC-CV̂C-CV-CV̂V-CV-CVC	'their deposits' (masc. pl.)

<sup>3</sup> Albert G. Abdalla, *An Instrumental Study of the Intonation of Egyptian Colloquial Arabic* (Michigan, University Microfilms, Inc., Ann Arbor, 1960).

<sup>4</sup> The maximum number of syllables in a word is nine, including affixes.



## VIII

### INTONATION

The analysis of intonation in this book is primarily based on speech utterances of the author and Mr. A. M. al-Mahmood — from here on referred to as informants A and B, respectively.

The corpus material is basically formed of lexical items, short phrases and sentences. The utterances are all of natural speech and were programmed with the various speech types that operate in the language, e.g., declarative statements, questions, commands, calls (vocatives), etc. This analysis, by all means, is not an exhaustive treatment of intonation but rather it is a modest representation of the main aspects that operate in the language.

All of the utterances, of both informants, were recorded on tape in a soundproof recording room. Then spectrograms were made, measured, specified and tabulated for every utterance of the data. Three kinds of spectrograms were made — broad band, narrow band (two and four inch), and continuous amplitude displays. Of these three types of spectrograms, the narrow band proved to be the most useful. Therefore, the utterances are primarily examined through the narrow band spectrograms. The tenth harmonic, in most cases, was traced through the utterance. If the tenth harmonic was not clear, the fifth was used.

In tracing the utterances it was noticed that the line of the tenth harmonic, in some cases, was interrupted. This was due primarily to the lack of energy in the area where the harmonic appears as gaps. These gaps are of stops, mostly voiceless, and voiceless fricatives.<sup>1</sup>

It was observed that a syllable with / ε / or pharyngealized coloring has a relatively lower pitch level than a syllable with no / ε / or no pharyngealized coloring, provided everything is equal.

Informant A, the author, has a higher pitched voice than informant B. Usually the difference ranges between 20-25 cps. This difference generally does not affect the intonational patterns throughout the analysis because it seems to be consistent.

<sup>1</sup> For further information on stops and fricatives see Chapter II.

## A. PAUSE

The sound sequences of the language exhibit two pauses — final, indicated by / ↑ / when rising and by / ↓ / when falling and non-final, indicated by / → /.

The final pause is easy to distinguish because it marks the completion of an utterance and is generally characterized by certain terminal features of the intonational pattern. These features depend on the type of the utterance. For instance, the final pause of a declarative statement is shown on the narrow band spectrograms by a downward glide. This glide is shorter with lexical items in isolation than with phrases and sentences.

The non-final pause is generally shorter in duration than the final pause. As indicated by its name, it marks the non-finality of an utterance and indicates hesitation or incompleteness. The non-final pause usually appears on the spectrograms as level. However, in a few cases, there is a slight glide either upward or downward. This slight glide is of no significance.

If an utterance does not have a non-final pause, it constitutes a one-breath group and is called a 'simple utterance'. If an utterance has one or more non-final pauses, it is composed of a more than one-breath group and is called a 'complex utterance'.<sup>2</sup>

## B. PITCH

The term 'pitch', as used here, refers to the fundamental frequencies of successive syllables in an utterance. It is different from stress inasmuch as it is not based on intensity but is entirely dependent on the relative fundamental frequency that runs through the utterance. This does not mean that stress and pitch never occur on the same syllable in an utterance as pitch may operate independently from stress and both may coincide on the same syllable. In utterances composed of more than one lexical item, it was noticed that the distribution of primary and secondary stresses does not necessarily coincide with the highest pitched syllables.

In examining the successive syllables, the different levels of pitch made it possible to compare and contrast the manners and directions of the intonational patterns that operate in the language.

Four levels of pitch operate in the intonational system. These are identified with the numbers / 1 / – low, / 2 / – mid, / 3 / – high, and / 4 / – extra high.<sup>3</sup> It is emphasized that these four levels are not absolute but relative.

Functional words — particles and prepositions — and suffixes and prefixes do not receive pitch levels / 3 / or / 4 / when they are contained in utterances of more

<sup>2</sup> Albert G. Abdalla, *op. cit.*, pp. 68-69.

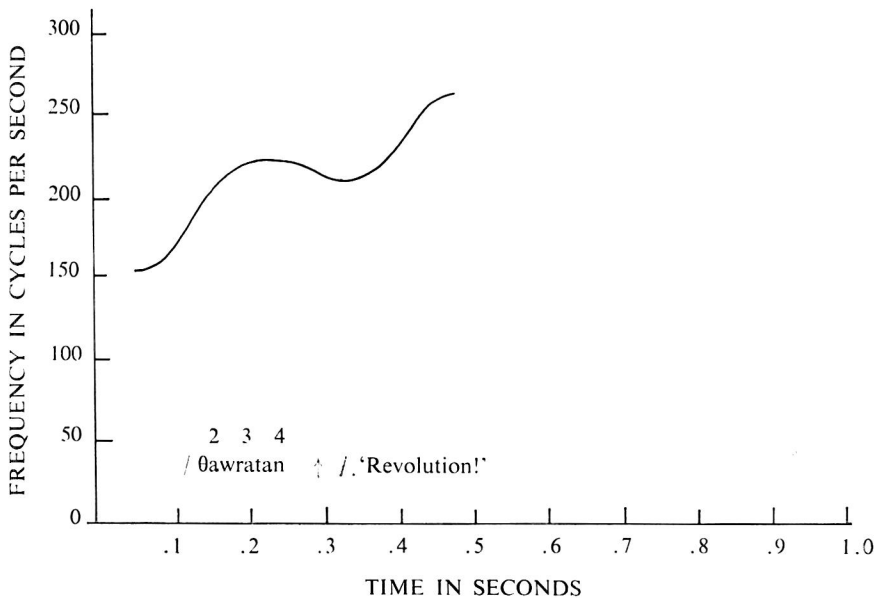
<sup>3</sup> Level / 4 / – extra high, is extremely limited in occurrence and distribution and does not initiate an utterance. It is mostly found in emotional utterances of great surprise, grief, happiness, etc.

than one lexical item. However, they may receive pitch level / 3 / when in isolation.

The pitch levels are illustrated below with different intonational patterns:

- (1)  $\overset{2}{/} \overset{2}{na\epsilon am} \downarrow /$  'Yes'. (Response to an ordinary question.)
- (2)  $\overset{2}{/} \overset{2}{na\epsilon am} \downarrow /$  'Yes?'. (Question in reply to a question.)
- (3)  $\overset{2}{/} \overset{3}{na\epsilon am} \downarrow /$  'Yes?'. (Response to an unknown or unexpected utterance. Such as answering the telephone.)
- (4)  $\overset{2}{/} \overset{3}{\theta awratan} \uparrow /$  'Revolution!' (Said with great surprise as a response to an unexpected statement occurring in the corpus material.)

The following tracing is of the fundamental frequency of the word /  $\theta awratan$  / as spoken by informant A.



The various types of utterances and their fundamental frequencies are discussed briefly below and the discussion is followed by a few examples which have been chosen at random from the data. For each example an utterance was traced, for both informants, along the tenth harmonic of the spectrogram. The areas that appear as gaps on the spectrograms are indicated on the examples by dotted lines.

### 1. *Declarative Statements*

Basically, the fundamental frequencies of the successive syllables of a declarative statement start with pitch level / 2 / which runs through the utterance until the final syllable where the level drops suddenly to / 1 /. This / 2-2-1 / pattern is referred to as sustaining falling. It may also start with level / 1 / especially when the utterance begins with a prefix or functional word.

The / 2-3-1 / pattern also occurs in declarative statements but it is less common than the / 2-2-1 /. Pitch level / 3 / appears as peaks when certain syllables are emphasized more than others. The number of times the / 3 / appears depends on the length of the utterance. See Examples 1 and 2, page 93.

### 2. *Commands*

A command statement is generally of the / 2-3-1 / pattern. The location of pitch level / 3 / is dependent on which word is emphasized by the person giving the command. Therefore, the / 3 / could occur first resulting in a / 3-2-1 / pattern. See Example 3, page 94.

### 3. *Questions*

The intonational pattern of a question depends on the location of the first high-pitched syllable. This syllable is relatively higher than any other peaks that occur in the utterance and following it there is a gradual descent to the end of the utterance.

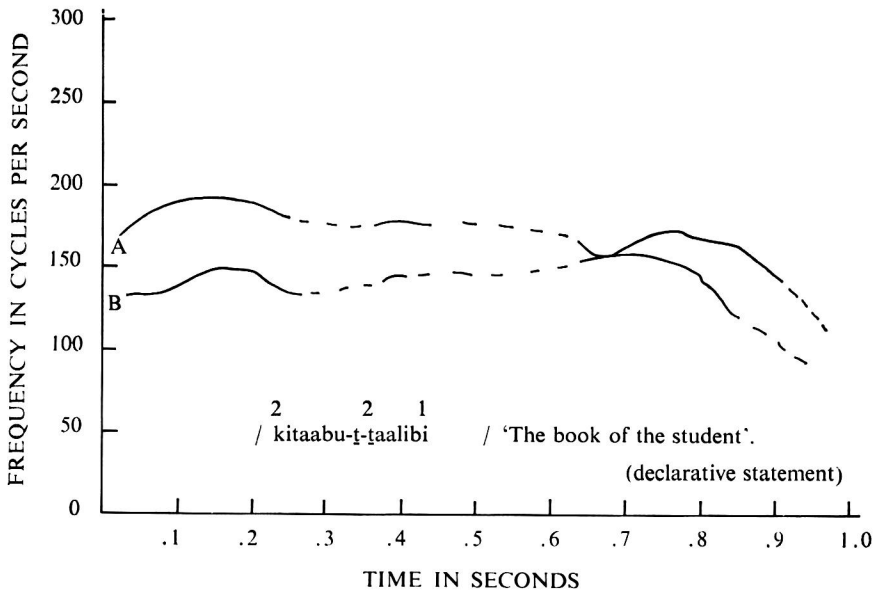
Therefore, the pattern of a question is either / 3-2-1 / or / 2-3-1 / depending on where the highest-pitched syllable occurs. (The highest-pitched syllable occurs either on the question word or on the word receiving the most emphasis.) See example 4, page 94.

### 4. *Calls (Vocatives)*

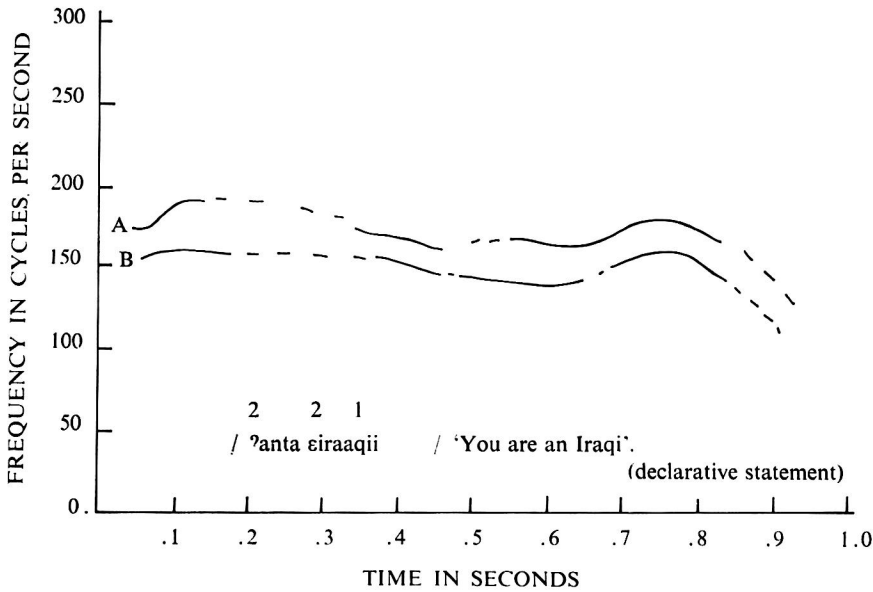
The intonational pattern of calls, / 2-3-1 /, is similar to the / 2-3-1 / pattern of the declarative statements. The difference between the two is a matter of detail. The calls patterns are limited in variation because of the limitation of construction. The patterns are shorter and are basically formed by the vocative particle followed by either one or two words. See Example 5, page 95.

### 5. *Exclamations*

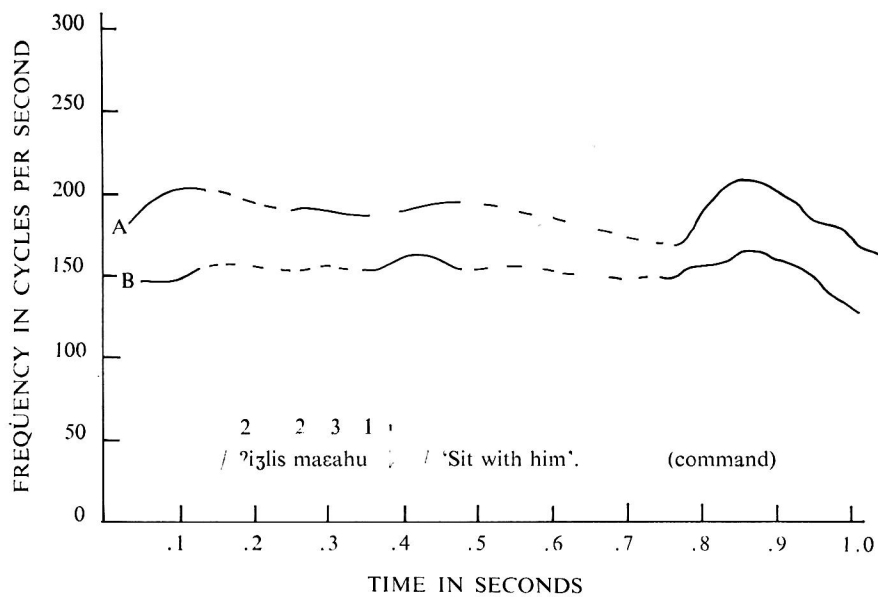
The fundamental frequencies of the successive syllables of an exclamation start with pitch level / 2 /, rise to level / 3 / — on the word that is emphasized — and drop to level / 1 / on the last syllable. See Example 6, page 95.



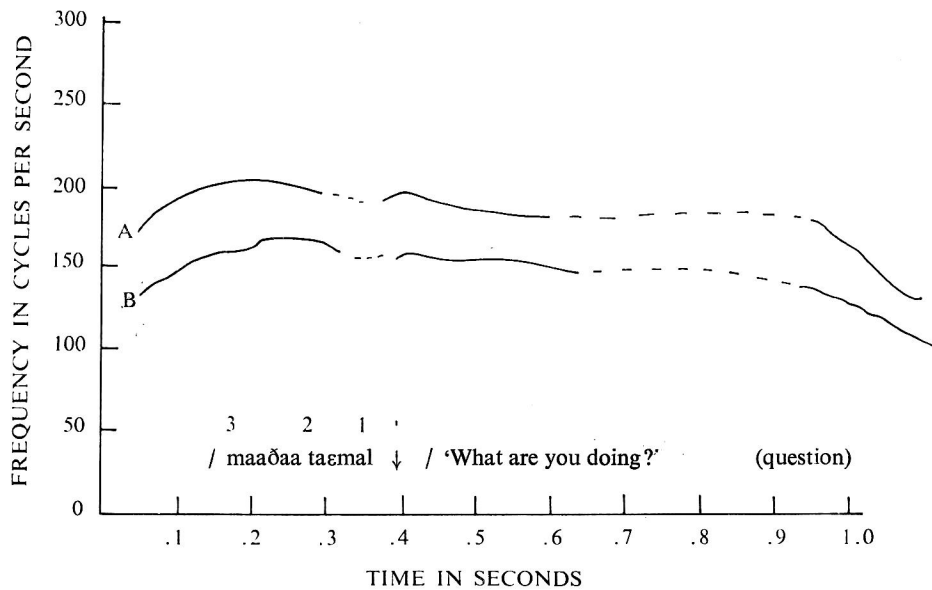
Example 1



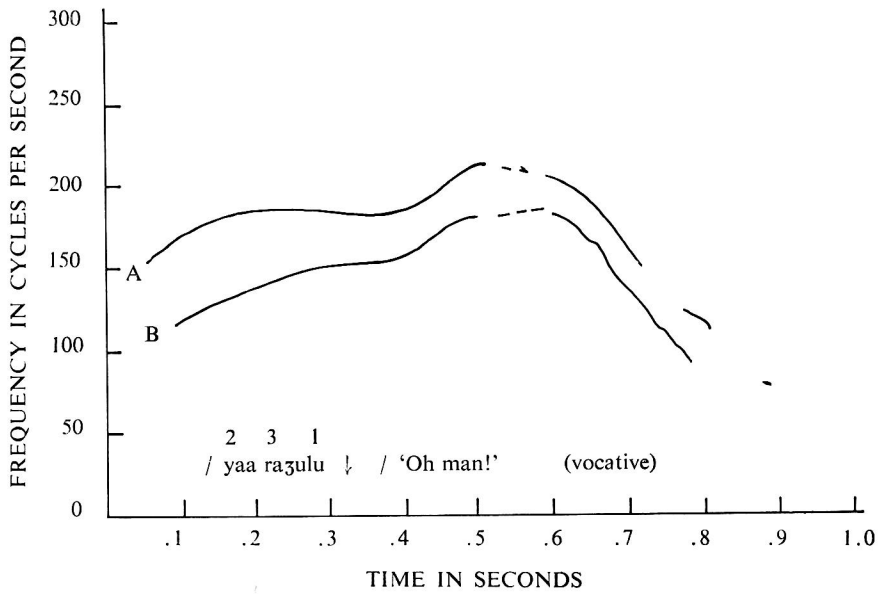
Example 2



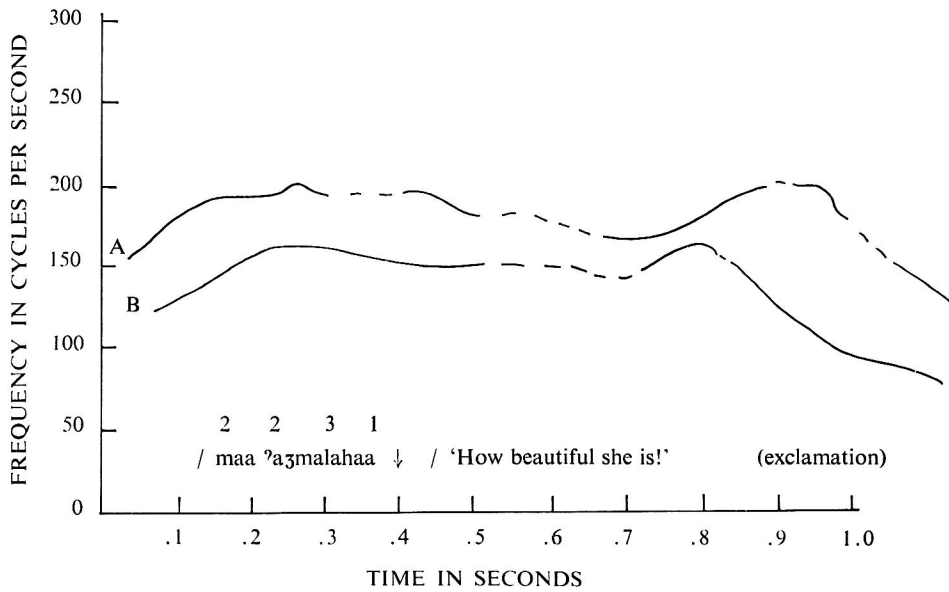
Example 3



Example 4



Example 5



Example 6

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